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WHAT'S INSIDE

Leave it to IBM and Compaq to steal the show. When PC Magazine planned a cover story on C compilers, we had no way of knowing that these two major players, ioined by ALR and Hertz, would be offering 25-MHz 386based screamers just prior to press time. Machines of this unmatched speed deserve cover treatment, and our First Looks staff responded on newspaperlike

Looks staff responded on newspaperlike short notice to produce nuts-and-bolts reviews of the four machines, complete

with PC Labs hands-on test results.

We can turn on a dime to review four state-of-the-art computers, but reviewing the latest C compilers takes planning. A major effort went into creating the industry's best C compiler benchmark tests. In the process, we committed our newest staff resources to do the job'. Pamela J. Milland, our newest Labs project leader, and Richard Hale Shaw, our newest commence of the process of the p

tributing editor.

Shaw's regular contributions to the Languages column demonstrate his C experience. In this issue he plays a major role in the C product reviews. And in PC Lab Notes, his part 2 of "Writing Optimal C" contains tips and techniques for optimization that will help speed up your programs and generally sharpen your C programming skills.

Speed is always a central issue, and nowhere is it more so than on a local area network, where a slow server or transmission scheme can bring down an entire workgroup's productivity. Telephone or twistde-pair-wing setups have always been

Programming expert and contributing editor Richard Hale Shaw presides over a C language compiler face-off.

branded as slow compared with coaxialcable-based LANs. Not satisfied with the conventional wisdom, our workgroup systems editor, Frank J. Derfler, Jr., ran three twisted-pair-wing systems from Hewlett-Packard Co., 3Com Corp., and SymOpties against a coax-based Ethemet LAN. The benchmark test results will probably surrrise vou.

All mass-storage disks are removable given enough time and effort, but—and this is no surprise—only a few can be put back again easily. For years the Bernoulli Box has provided a reliable means to carry away large amounts of data on a disk with no hassle. In this issue we explore how the Bernoulli Box It stacks up against the alternative technologies that have sprung up in this burgeoning market.

Price/performance issues are moot when it comes to the utilities published in PC Magazine—they're free! This issue we offer FONTEDIT, Which lets you create custom EGA and VGA screen fronts. Try it, it's fun and useful. If you don't have a knack for C programming, you may have an eye for design.

Fr. Higgerer, The Independent Counts in 2009 Standard Presson Computing 2009 (1900) 1-2009 1-2009 is published to enough yearing on the part 10 for one year CII and IV the county years and the 17 for the year CII and IV the county years and the CII and the processor of the CII and the CII and CII and

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FEATURES

Charles Petzold/ The power and flexibility of the C language are quickly making it the programmer's language of choice for applications development......92

Compiling the Facts on C Richard Hale Shawl PC Magazine tests the latest arrivals in the C compiler

market. PC Labs' new C compiler benchmark tests challenge products from Borland, Computer Innovations, C Ware, Ecosoft, Lattice, Manx, Mark Williams, MetaWare, Microsoft, Mix, and

Watcom......115 ANSI C Compatibility Features Table...... 144

3Com: best choice for small work

groups, page 189.

CONNECTIVITY Making Connections: Fast Performance over Telephone Wire Frank J. Derfler, Jr./3Com. Hewlett-Packard, and SynOptics all offer systems that send your data over twisted-pair wiring at rates competitive with coaxial-based MASS STORAGE Removable Mass Storage:

You Can Take It with You Mitt Jones/ Removable hard disks and cartridges offer data security and portability advantages over traditional mass storage. Products from Aristotle, Eastman Kodak, Iomega, Plus Development, ProStor, Qume, SyQuest, Sysgen, Tandon, Tradewinds Peripherals, and Western-Dynex offer you a variety of price/performance options 213

Performance Tests 244 EDITORIAL PRODUCT INDEX

The complete listing of products reviewed in this issue, plus a quick reference to utilities, programs, and tips in the Productivity section ... 438

Cover Photograph: Roberto Brosan



and others challenge Bernoulli, page 213.

C compilers have

improved dramatically since 1975, page 92.





Hands On:

· 25-MHz pioneers: the fastest PCs money can buy, from IBM, Compaq, ALR, and Hertz

· Sprint: Borland's

- innovative, high-powered word processor mimics competitors' commands · Seiko's budget-minded monitor challenges the IBM
- · Paradox OS/2 shows what OS/2 is all about with tricks DOS applications can't touch
- · Pipeline: The DRAM shortage in perspective
- . Lotus's Value Pack zans 1-2-3 copy protection
- · PagePerfect integrates word processing, desktop publishing CrystalPrint WP delivers laser output at half the price .33

AFTER HOURS

- Systems from Roland, IBM, and Music Ouest can turn your PC into a music-maker · CD-Play and CD-AudioFile bring the magic of music to
- your CD-ROM player . For Record Collectors: a database for your music collection
- · Gunship: Keeping the world safe from Communism 448

PRODUCTIVITY

PC LAB NOTES

write using these optimization tips and techniques 285

Making Your Own Screen Fonts

Michael J. Mefford/ Create, modify, and load your own screen fonts easily using FONTEDIT-a utility that puts custom EGA

PC MAGAZINE HELP FILE 283

ENVIRONMENTS

Presentation Manager Dialog Boxes, Part 1 Charles Petzold/ Improve your Presentation Manager screens

by including dialog boxes . 327 POWER PROGRAMMING

The Quicksort Explained Ray Duncan/ A practical C implementation illustrates one of the best general-purpose

sorting algorithms 341 SPREADSHEET CLINIC

Douglas Cobb and Steven Cobb/ A foolproof way to ause a Lotus 1-2-3 macro; a beneficial bug in SuperCalc; an easy way to convert six-digit

labels to serial date values in

ms for your PC, in After Hours, page 448.

Writing Optimal C, Part 2

Richard Hale Shaw/ C programs that execute faster are easy to LITTLE ITIES

USER-TO-USER

Salvatore P. Ricciardi/ Save disk space by combining batch files; accelerate repetitive tasks using DOS redirection 353

POWER LISER

Craig L. Stark/ How to print the current screen from inside dBASE III Plus automatically: nested macros speed up glossary entries in Microsoft

LANGUAGES Robert L. Hummel/ An casy

way to copy files in QuickBASIC; a simple program that converts real numbers to different formats in Turbo Pascal 367

PC TUTOR Robert L. Hummel/ Selecting

an upgrade path from among many multitasking alternatives: a full explanation of the RET instruction 377

CONNECTIVITY CLINIC Frank J. Derfler, Jr./ A simple utility that captures NetBIOS hexadecimal return codes and translates them into English: the best way to make wide-area connections between local area

LETTERS TO PC MAGAZINE.....

PC ADVISOR

Joe Desposito/ Upgrading memory in an AT; converting CP/M-based information to MS-DOS; print spooling and disk caching from extended memory......27

BILL MACHRONE Getting CEOs to Use

JOHN C. DVORAK

Selling Sizzle with the ak......71 Inside Track.....



JIM SEYMOUR PS/2s: Reliability Count\$..77

STEPHEN MANES Computer Lib: Blast from the Past85

Direct Marketing Connection391

Marketplace408 Index to Advertisers...437 Reader Service Card .. 439 Coming Up441 Advertisers' Product Index442



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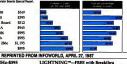
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Memory Resident

That's because the idea of a memory resident spreadsheet makes sense, one that you can pop-up instantly while working in your word processor or any other program. Lucid lets you cut anything on the screen and paste it right into Lucid, or cut anything from a Lucid worksheet and paste into the application below. You can even run Lucid on top of 1-2-3 if you like, and cut and paste information from one to the other, including formulas.

Lucid 3-D was developed over the past two years with countless exhaustive hours of planning and programming to produce something spectacular. This is a product that works the way we dreamed a spreadsheet would function. Everyone who has seen it says things like. "Lucid 3-D is flow softwar of the 1990's will book and profirm." Or even more to the point "This is the way I shought a computer should work". You'll see. Lucid is exciting.

Masterwork

We could go on at great length about all the features and innovations in Lucid but Lucid is more than a bag of features. What is most important is the pride and craftsmanship that went into its creation. It is a masterwork. The overall feel is tight and polished. In fact Paul. Somerson, editorial director of PC Computing, used one word to describe it. "Side?"

PCSG has built a reputation as a development laboratory producing products that you know are excellent. In 1983 PCSG dominated the Model 100 laptop market with ROM based software that every reviewer rated as



POP-UP 3 DIMENSIONAL SPREADSHEET

excellent. In 1985 we produced Lighthing, the pioneer and award winning Disk speed up software. In 1986 we developed the Freakthur 286 accelerator board that blew everything else out of the water. and later we topped ourselves with the Breakthur 12. Now in 1988 those who have worked with Lucid 3-D tell us "you knot done it again. This is software everyow should fame."

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Any cell can contain a com that you can access



Fig. 1 Let's get the detail on those ad costs. Just bar to that cell and press one key





Fig.4 Now, instantly we are on level 3. Each level is e different

the detail on that figure. There is no limit to the levels you can go

What Makes Lucid 3-D So Special

In the screen examples you can see Lucid is really three dimensional. Any cell of the spreadsheet can contain a complete other spreadsheet that you can access with a single keystroke. It is as simple as the pictures show. And you don't have to write formulas to do that

All you do is go look at the other file, navigating through easy, point and shoot directories. When you come back up (with one key) the link is made automatically for you.

Everything about Lucid works that way. Users say "It is so intuitive that I really don't need a manual." That's because we use something we call a visual command menu. Iim Seymour, the noted PC columnist, talking about Lucid in a recent article said that, "If there ever was an interface idea so accod it ought to be stolen and widely used, this is it." What he was talking about is a

new menu approach that follows a simple design concept; it is easier to recognize than it is to remember. As choices are made on a menu that take you to lower levels you always can see exactly where you came from and where you are going. The complete menu path is always visible. You cannot get lost several levels down. This means you never have to remember a command, you just flow right to it.

Plus, no matter where you are on a menu or what you are doing, just press function key Fl. and you will get a help screen specific to that command or action. Or if you want to know about any subject you can pop up an index of over 600 topics and select the one you want.

Notepad Behind Every Cell

Another 3-D feature is that any cell can also contain a multiple page note that you instantly access with a single keystroke. You can write notes. memos or letters that relate to your work, save them as individual files and even print them separately or with your spreadsheet.

screen are completed. Other calculations you don't see continue on in the background during the next commands. The end result of this powerful combination is you rarely wait for a recalculation with Lucid You find out what instantaneous is all about

"I've been calling it an 'Everyman's Spreadsheet'. and I think that's how the market will position it. It's much more than an inexpensive alternative to 1-2-3.11

Speed

Lucid 3-D is truly revolutionary. It is fast, fast, fast! It is incredibly quick in performing calculations because it doesn't recalculate every cell every time you insert an entry. Instead, it only recalculates the specific cells that are affected by your change. This is called minimal recalc. Lucid also has a remarkable innovation called background recalc in which you are given control of the cursor the moment calculations affecting your viewing

Jim Seymour, Columnist, PC Magazine, PC Week

Lucid Learns

Lucid 3-D also lets you teach it in any combinations of keystrokes so that involved sequences can be done with single keys. Plus more than just remembering keystrokes. Lucid allows you to create Macros with loops, procedures and conditional branching amazingly all done automatically with simple menus. You can create your own menus that show the new features you have taught it. Another great feature is

olete other spreadsheet with a single key.



Notice, you can simultaneously open windows in different directories, different drives, even down as many 3-D levels as you like. No one else can do that.



Perfect letter we are writing. Clipboard Dump does it right now.



Fig. 7 Here it is right in Word Perfect (or any word processor) just fike you typed it. You can go the other way just as easily.

you can make your custom menus work like Lucid where one choice can take you down a level to a whole new set of choices. What's nice is that they will work from one spreadsheet to another.

Mouseability

Lucid 3-D was designed for both lephoard enthusists and mouse loves alike You can take your pick. Designed around the mouse from the ground up, the interface is smooth and natural. You select files to load from directory lists. Everything is point and cick. What's more any Lucid 3-D menu selection can be supported by the pick of a did not be exported to the selection of the pick of addom nouse menu systems like those you've seen with 1-2-3. A window goos up with a library A window goos up with a library and the pick of pi

of function names you can page through with the mouse Select, click and it is in the formula with no typing required. You even have a label window that you can fill from the keyboard with favorite labels and names so that you can insert them later with the mouse. There's even a pop-up calculator to insert numbers so you don't have to go to the keyboard very often. It really reemits that feeling of

becoming one with your work. Lucid

3-D has windows of user defined range names as well as the macros named by the user that can be selected just by pointing and clicing, loans that are easy to grab with the mouse let you resize and move the spreadshet window with the esser you would expect. Plus you can go anywhere on the sheet by moving the mouse and clicking on the spreadsheet borders. And remember, Louid is designed so that any of those features are done with or without the mouse easily and quickly.

Audit

When you are staking a big decision on information gained from a spreadsheet you need to be certain that you have made no mistakes. Lucid 3-D offers five audit displays and printouts.

Even if you don't plan to abandon 1-2-3. Lucid makes sense. Files are converted between them with ease so there's not an interoffice compatibility problem. This means you can have the power and fun of Lucid 3-D without having to upset your present systems.

We are excited about Lucid 3-D.

But don't take our word for it, take
us up on our 60 day offer.

Call us on our order line number and we will ship your order the very next day. This \$149 offer will end as soon as our dealer network is fully stocked. But in the mean time we invite you to try Lucid as part of our "spread the news" campaign, flust pick up the phone and call us. We accept all major credit cards or you can order COJ.



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Plus, it guarantees



Faster.

Though other high-speed modems may claim speeds up to 19,000 bps, they rely exclusively on data compression, and can only achieve these speeds on excellent quality phone lines.

But the Pathfinder 18K has a unique ability to adapt to the changing quality of the typical phone line: it falls back in small 100 bps increments and can bounce back again when line conditions improve! So in



are-perfect transmission for CAD/CAM and graphics."

the real world, it actually transmits nearly twice as fast as other modemsup to 18,000 bps without data compression. Keep that in mind when comparing modems.

What's more, if lines do deteriorate badly, the Pathfinder 18K's own data compression automatically kicks in to keep you moving at the highest possible speed.

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* high-speed LAN gateways * desktop publishing * remote computer diagnostics. They're all feasible now, thanks to the Pathfinder 18K's great speed and accuracy. Besides which, the Pathfinder 18K can perform more routine tasks in a fraction of the time, and at a fraction of the cost. of conventional modems.



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The Pathfinder 18K is on excellent speaking terms with more leisurely-paced 2400. 1200, and 300-bps modems. And it's supported by more communications packages than any other high-speed modemincluding PC-to-PC, PC-to-mini, PC-tomainframe, LAN and Macintosh software.

Call us at 800-538-5121. We'll be happy to show you how Ven-Tel's Pathfinder 18K can get rid of your data transmission hang-ups. Faster than you ever thought possible.



LETTERS TO PC MAGAZINE



UNDERSTANDING OS/2

I appreciated Jim Seymour's commentary on the memory requirements for running OS/2 ("RAM Scam "88," PC Magazine, May 31, 1988). People who upgrade to OS/2 should understand what is in store for

laiso appreciated his remarks about protectionism. The world has shrunk, and it has become expensive to favor domestic suppliers. Instead of restricting imports, we should work on increasing exports. Favors to American chip makers harm American computer manufacturers as well as all American computers. Scrabers Residence of the strategies of the computers.

Stephen Rawlinson Sunnyvale, California

MORE OR LESS

Contrary to Richard H. Gleick's letter (Letters to PC Magazine, PC Magazine, June 14, 1988), the statement "I could care less" is correct English. It is uttered in an ironic tone, rather like "I should care?" and has a Yiddish flavor.

"I couldn't care less" means the same thing but is stated literally, and people not from New York find it easier to interpret.

Michael Covington, Ph.D. University of Georgia Athens, Georgia

LEXITYE ADMANCS TECHNOLOGY
The review of Lexityee Plus II ("Fast II.
Flexible, and Forward-looking," IEEE Live II.
Magazine, February 29, 1988) contains
distortions of fact and factual errors.
Housely high beauty and strength of Lexitye
tie in its fundamentally different apposeds
to word processing; your reviewers appear
to have completely missed the point. For
example, Lexitype's use of color-coded
tectors is combelled in fact of the re-

view. The use of meaningful document titles is not even mentioned. And your discussion of Lexitype's Full Page display



(which shows the operator the format of the entire page of text on the screen) is obscured by your obsession with whether or

not it is "ima" WYSIWYG.
But most uperting is your assertion that
Lexitype "does not take advantage of carnet K' software technology." If "PC
printers, local area networks, and so on,
Lexitype supports all of these, and we are
committed to supporting energing technologies as well. However, if "PC technology" means cipit-charater fileatment
hidden codes, and so on, then perhaps,
Lexitype has simply surpassed current PC
technology.

Lon J. Berman President Lexitronics Inc. Sterling, Virginia

Lexitype Plus II emulates a typewriter. Keytops identify key assignments that differ dramatically from other DOS applications (the Up Arrow, for instance, moves the cursor down). Undo and justification function page by page, Reformat adjusts

imparted documents to Lexitype's mugins. Files are soored in ubindexes that are shareable in its network version. Because of a production error, the following features were incorrectly listed as not validable: right sulfication; variable line spacing; page numbers automatically rese; paragraph delete: line, paragraph, column, and page block; case-sensitive search; persevers case when replacing; recognizes whole words; search-andrepred, forms color state and page from the color of the search-andreing; temporarily goes to DOS; and preformated forms rocessing.—En

IBM: FAKING PS/27

I am writing in reference to Charles B. Holleran's letter (Letters to PC Magazine, PC Magazine, June 14, 1988), in which he criticized Bill Machrone's statement that the IBM PS/2 Models 25 and 30 may not be legitimate members of the PS/2 family.

I agree with Mr. Machrone, and I sincerely believe that IBM is trying to pull the wool over the eyes of first-time buyers. Mr. Holleran himself detailed the characteristics and capabilities that the PS/2 family of computers is supposed to possess. He wrote, "Annong those features are 31% inch diskettes, improved graphics, and advanced functions integrated onto system boards."

Although the Models 25 and 30 have 31/s-inch floppy disk drives, they are formatted to hold only 720K of data. The true PS/2 holds 1.44MB of data. The Models 25 and 30 do not support VGA graphics but, rather, use an enhanced version of CGA known as MCGA.

I am not aware of any advanced functions that the Models 25 and 30 possess. They do not have the Micro Channel archi-

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EDUCATION 9-Learn French skills wio borng teachers! EDUCATION 10-Practice German with these easy drills. MCE ta.b-(2 disks) A personal bookevoing manager. NANCES 3a,b—(2 disks) Prepare financial spreadsheets.

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MFS 3—Rischieck (you set rules). Armchair CB. Empire. SAMES 4-Star Trek, the orig Colossel Caves Advent, more SAMES 5-Hack, you and your trusty dog in a wild advertur GAMES 6-Pritell, Othello, Dragons, Sopwith (fly one). * CAMES 8-Blast enemies wStriker, conquer world w Risk * GAMES 11-High res Aldo's adventure, Mahulongo, EGA.

GAMES 12—Try backgammon or Wordplay fortune wheel! GAMES 13a,b,c,d,a—(5 disks) Make yr own advent games! take color slide shows for demostrarring! * PHICS 2a,b,o-(3 disks) Produce great 30 graphics. * IUMOR 1-Amuse wifun faces, unifiendly DOS & mor INFO 1a,b-(2 disks) 150+ get cooking recipes. Add ye own!

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■ LETTERS

tecture that the true PS/2s have. They don't even have an advanced CPU, which means that they won't run OS/2 or Microsoft Windows/386.

In other words, the IBM Models 25 and 30 are nothing more than old PCs in new boxes.

S. R. Perry Vallejo, California

CHECKING OUT CONNECTIVITY I do not ordinarily write to magazines, but I did want to compliment you on the recent workgroup-computing issue ("Software:



Connectivity's New Frontier," PC Magazine. June 14, 1988). It was great to see a serious, comprehensive look at the group connectivity tools now available. Kudos to Frank J. Derfler, Jr.

> Richard Anders Cambridge, Massachussetts

STOPPING AT EPSON Your review of the Epson Equity LT

("Planes, Trains, and Automobiles: 12 Portables for the Road," PC Magazine, March 29, 1988) seems at odds with the reviews of other portables in that story. I am confused as to why the NEC MultiSpeed HD and Zenith Z-183 received a thumbsup, while prospective Epson Equity LT customers were admonished to just "walk on by."

My confusion stems from the fact that all three models are almost identical. The Summary of Features table shows the Equity LT to compare quite favorably with the other laptops in its class. Furthermore, your reference to "Joe

Isuzu" implies that we are trying to deceive the end user. Not only is this blatantly untrue, but the comment borders on iournalistic irresponsibility. We believe our customers should have a

choice of configurations to match their budget and requirements. Screen configurations, hard disk drives, and modems are common industry options, even for

Believe it or not, our screen is similar to

the screens of both the NEC and the Zenith. The perceived difference in readability is a function of the individual operating parameters determined by each manufacturer. The Equity LT's character display was selected to provide a differentiation between normal narrow characters and highlighted wide characters.

The reviewer writes that at 14.2 pounds, the Equity LT is "just too bulky to be a comfortable traveling companion." But according to the features table, our product matches up well with the heavier NEC (14.3 pounds) and the bulkier Zenith (15.8) pounds.

If we are confused by the mixed signals your review communicates, we believe your readers also will be confused

Scot Edwards Epson America Inc.

Torrance, California True, the Equity LT does generally match

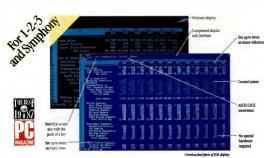
the specs of NEC's MultiSpeed HD and Zenith's Z-183, but the perception of a screen's performance is ultimately a subjective judgment. PC Magazine did not mean to characterize Epson's marketing nlan as deceitful and recrets any implication to that effect .- Ed.

WYSE VERSUS ZENITH

I have found your product reviews to be fair and objective, generally speaking, but I must take exception to the results of your review of 80386 machines ("Three 386s: Stretching Performance at 16 MHz," PC Magazine, May 31, 1988)

I don't understand how you could have chosen the WYSEpc 386 over the Zenith Z-386. The Z-386 was clearly the fastest machine in all of your tests, and it comes equipped with an EGA video board and Microsoft Windows/386. The Z-386 also has 4MB memory boards with EMM capability and a version of OS/2

Zenith has a nationwide chain of sales and repair centers, and while the price seems high, the machine is normally discounted. It is also available as a kit through



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Small	106x33	128x43	106x48	120143	128x50
Very Small	128x25	150x51	128x53	144143	N/A
Thray	128x33	160x58	160160	180x58	160±66

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■ LETTERS

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J. J. Thompson Kenmore, New York

Speed is only one aspect that is taken into consideration when evaluating a computer system. Design, construction, and (of course) price factors are also important. In the judgment of PC Magazine, the superiority of the Wyse in these other areas should prove more valuable to you, the user, than the small bit of additional speed that the Zenith delivers .- Winn L. Rosch

LIVING WITH EGA

I find it interesting that you say EGA is all but obsolete ("Making Way for VGA," PC Magazine, May 31, 1988), yet in your review of the new 386 boards ("Three 386s: Stretching Performance at 16 MHz," PC Magazine, May 31, 1988), you tested all of them with EGA. Is this consistent?

Brian Peck Milwaukee, Wisconsin

EGA is dead as far as a new system or display adapter is concerned. Neither IBM nor Compaq even makes them anymore. VGA does everything EGA can do-and more. Of course, millions of EGA adapters are in machines and will continue to deliver good images for years to come. You can still use EGA and be happy; just

don't waste money buying a new one. PC Labs tests with EGA for standardization and to reflect its currently wider

application .- Winn L. Rosch THE TRUE WINNER: FILE-BY-FILE

In his sidebar "Image vs. File-by-File: Two Paths to Tape Backup" ("Hardware Standbys: PS/2 Tape Drives," PC Magazine, May 31, 1988), Richard Hale Shaw states that "image backup is really useful only when you've had to replace your hard disk or when you want to replicate your entire system on another hard disk.

I disagree. When restoring an image backup to a different hard disk, you run the real risk of writing data to bad tracks. An image backup is a sector-by-sector replication of the original data. The data backed up from sector xyz on the source disk will be restored to sector xvz on the target disk.

even if it has been previously identified as unusable.

Unless your new hard disk has no bad tracks or, at most, a subset of your original disk's bad tracks (what are the chances of either?), you're playing Russian roulette with your data. File-by-file is the only way to 20.

> Steve Offner Carlshad, New Mexico

THE POWER OF IBM

I definitely agree with John C. Dvorak's views regarding the change of the hardware industry ("Repent! The End Is Near," PC Magazine, June 14, 1988) from one in which prices drop to one in which prices rise. Mr. Dvorak forgot. however, that the inherent big winner in this mess is known by the initials I., B., and M.

The reason is simple: unlike other comnuter companies. IBM is easily capable of producing virtually every component of a computer system. Because of this self-sufficiency. IBM is less sensitive to market

conditions for critical computer parts. The results are obvious: while everybody else will be forced to curtail production because of ruinous parts shortages, IBM can build Personal System/2 computers for any level of demand. With this advantage. IBM could also sell the PS/2

computers at almost any price. In short, the semiconductor agreement between the United States and Japan has played right into IBM's hands; the big loser is us end users

Raymond Chuang Mountain View, California

CORRECTIONS/AMPLIFICATIONS

The phone number listed in the fact file for 10NET Communications ("A Field Guide to LAN Operating Systems," PC Magazine, June 14, 1988) is incorrect. The correct number is (513) 433-2238.

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PC ADVISOR



Topping off RAM on a 512K AT, converting CP/M files to MS-DOS, and programs that use extended memory for print spooling and disk caching.

MEMORY TOPOFF

I have one of the first ATs—512K—and need to up my memory by 128K to 640K to get better use of software. I don't foresee any need for expanded memory. What would be your suggestion for the cheapest way? Also, could a novice perform the upgrade?

Betty H. Scott

Jackson, Mississippi

You've picked a bod time to think about upprofiling the moment is powed. To all upprofiling the moment is powed. To all your, For instance, in the Cotober 13, 1987, issue of PC Magazine, Arlington Computer Products (3025-E. Melmon, Arlington Heights, IL 60005; (8001) 548chips (1982 Lin Heb. Line 28, 1988 and of PC Magazine, the same company has of PC Magazine, the same company has littled those memory chips for 550 (more than a 100 percent increase). So for the time being, them god memory are not

There is a product available that will be you expand your AT's memory to just 640K—Top Hat (Boca Research, 640I, Congress Ave. Boca Raton, F. 13487; (305) 997-6227). Although it has a sugested retail price of \$165, you can buy it through moil order for considerably less. For example, Computer Mail Order (101 Reighard Ave., Williamsport, PA. 17701; (800) 233-8805) lists Top Had or \$999.

The Top Hat board is for AT computers with speeds up to 8 MHz, which is perfect for you since you have one of the older ATs. For those who own a faster AT-type

computer and also need this upgrade, Boca sells a 12-MHz version of the board for \$175.

Even novices shouldn't have any trouble installing inter of these boards, via simply remove the cover of your system and insert the expansion card into any available 16-bit shot (the longer connetors) at the reas of the system board. Then use the steep disk that came with your AI to tell your computer that you've your performed only once; the information is stored in the computer's battery-backed CMMS RAM!

If you change your mind about limiting your AT's memory to 640K, Boca and many other vendors sell expansion boards for ATs that will let you expand your system memory to several megabytes. These types of boards (LIM 4.0 memory boards) are scheduled for review in the October 11, 1988, issue of PC Magazine.

time to upgrade the memory in your AT. Prices of memory chips have soared more than 100 percent.

You've picked a bad

CP/M to MS-DOS

How can I convert CP/M-based information to the MS-DOS format (3.x)? Two hospital departments have some historical data on an Osborne and a NorthStar (great boat anchors).

Kent E. Lederman Atlanta, Georgia

Blue Hernes (1908. S. Second St. Decken hos products that may help your solve your products that may help your solve your products that may help your solve your product shall collower data is in doubte-density format, you clot make a software product called (volumen, which selfs for mat. If the NorthStur data is on hard second data; data is on hard second data; data with more than one small hole punched in the medal, you can use a handware product called Match-Point, which selfs for \$185. MatchPoint is table of \$1.00 to \$1.00 to

If the transfer you need to make is a onshort deal, you might consider connection that and part of your Oxborne or North-Ster to the serial part of your PC. You can then transfer the files from one computer to the other. Although simple in theory, this is sometimed difficult in practice. You will be sometimed to the process of the proton both computers that will let you do a ditect transfer from computer to computer, and an appropriate (mill modem) cable to connect the two serial parts together.

Alternatively, you can use a modem to send the CPIM files over the phone lines to your PC. Files can be sent directly to your PC or through an information or e-mail service such as CompuServe, MCI Mail, or even a local bulletin board.

CACHING IN EXTENDED MEMORY

I have an AT with 366K extended memory. I would like to use it for something other than a RAMdisk. Print spooling and disk cache would seem to be ideal applications, but I've not seen either of these utilities available in a version that supports extended memory. Can you offer any suidance?

Steven Garbarino Ann Arbor, Michigan

A program that will let you use extended memory for print spooling is Printer Genius, from NOR Software (527 Third Ave. #150, New York, NY 10016; (212) 213-9118). The program first redirects printer output to a disk file (in this case, to a file on an extended-memory RAMdisk). Then the program will let you invoke a background

print option to print the disk file anytime you like.

Printer Genius is a memory-resident program that works from within your application program. Besides print spooling, it allows you to take full control of the various features of both dot matrix and laser printers. The program's suggested retail price is \$89.

There are other programs on the market hat will do the same thing. For example, both Friii Q and Dute till print to a RAM dist, and both offer a host of other features, too. Print Q sells for \$89 (Software Directions Inc., 1572 Susser, Pipte., Randolph, NJ 07869; (201) 584-8466) and Dute stells for \$89.93 (Consumer Software Inc., 736 Chestmut St., Santa Cruz, CA 95060; 4698 426-7311).

For disk caching, a favorite in the Labs is Super PC-Kwik Disk Accelerator from Multisoft (15100 SW Koll Pkwy., Suite L, Beaverton. OR 97006: (503) 644-5644). which sells for \$79.95. Multisoft also sells PC-Kwik Print Spooler for a suggested retall price of \$44.99. The two programs share extended, expanded, or conventional memory. Memory is automatically allocated for printing, and it is returned to the

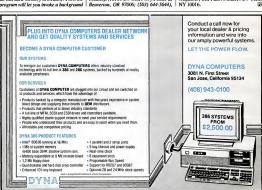
disk cache program when your printing is done.

Another caching option is Vcache, a S39-95 program from Golden Bow Systems (2870 Figh from Golden Bow Systems (2870 Figh Ave., #20). San Diego, CA 92103: (800) 284-3269). Vcache lets you allocate up to 15MB of extended for expanded memory to speed up disk operations.

Joe Desposito is the senior project leader of PC Labs.

ASK THE ADVISOR

Send your questions to PC Advisor, PC Magazine, One Park Avenue, New York, NY 10016



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allows the programmer to build a date alows the programmer to board a claim-base application using any language. It takes complete charge of all file creation indexing, residing, writing, mechos, deletion, forward and backward nearch-ing. Its balanced tree indexing scheme finds any key in a million in less than 4 accesses. That's fast!

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more than 30 language interfaces (incling C, BASIC, PASCAL, FORTRAN). wever if it turns out that you see up remetions a little amoraal, worry not. The write a language interface to Binewe. Binewe's vital statistics are equally in pressive Files may have up to 24 poless fixed record length to 4090 characters. wariable length to 94K, indexes to 255 characters, tiles of 4 billion bytes. Net-work support includes Novell, 3-COM, IBM PC NET, Software Link's Multifink

and many others. XQL is a relational database man ment system designed especially for pro-grammers. Imagine being able to access z desabase with the ease of SQL nuctured Ouery Language) state and still having the power to process that data right down to the byte level. Think about your applications: A large part of your software development effort is probably devoted to managing data

stored in files on disk. Hours spent writ-mu lines of code to search and store data

records could have been used to program more important parts of your application. Why not let XQL do # for you.

XQL will increase your programming productivity and let you focus on building

better applications.

The XQL system works in tundem with Braces and has an equally powerful chains. No limit on the number of records per file. Max file size is 4 citylets, Max, record size equals K, Max, indicates per file is 24. The one wirmon. works for single or multiuser systems, DOS Ver 3.0 or greater. All languages e supposes. Xtneve is the final ingredient in the Novell programming recipe. It is a menu driven, data retneval system, that allows you to quackly find information and dis-play reports. System developers can easily customize Xtneve to display com mund menus, help files, and error mes seges in the English spoken by the cus

tomer. Xtnews across shen gives menchoices that users can quickly recognize making Xtrieve an easy product to use sport Option for printing custo reports, form letters, masked labels &

and understand

Btrieve/N XQL Xtneve/N sport Option/N

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2b and has all its drivers and language 2b and his as as current and susquence budings Macro level tools to draw, color, segment, transform, store and recreate an object. The Metalile Interpreter reads ANSI CGM ties with full CGI capability for recreation on various devices.

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FIRST LOOKS

Four 25-MHz Trailblazers: Dazzling Speed, Plenty of Storage for a Price

BY JOHN DICKINSON

The latest 386 PC performance standard requires a 25-MHz clock speed and, make no mistake about it, power users will flock to these speed kings like lemmings to water. So will MIS managers and PC coordinators looking for the best LAN file server, as will VARs and consultants cooking up Unix configurations for vertical markets. In the following pages, we

review the first four 25-MHz machines to make it to PC Labs-Advanced Logic Research's Flex-Cache 25386, Compag's Deskpro 386/25, the

Hertz 386/25, and IBM's PS/2 Model 70-A21. Only the Model 70 was not yet shipping as we closed the issue; it should be shipping by the end



How fast are these machines? Fast enough that timing the four new 386s became an exercise in splitting hairs and

counting angels.

The numbers are small, and the performance differences among the machines are small as well, thanks in part to the static RAM cache and ESDI disk subsystems that each system sports.

But even in a tight race. somebody crosses the finish line first, and the ALR FlexCache 25386 takes top processor performance honors. IBM's Model 70-A21 places a close second. Disk performance is a bit more mixed. Your choice there will probably depend on the type of application you're running; database users will like the Hertz

(continues on page 34)

Sprint Mimics Word Processors. Packs Host of Powerful Features

HANDS ON

BY CRAIG STINSON Borland International's Sprint might well be called the word processor of a thousand faces, except that "a thousand" is a bit of an exaggeration, and "word processor" is something of an understatement.

The product's most effective selling point is its soft user interface. In addition to its own pulldown menu trees, Sprint offers emulation trees for EMACS. Final Word II. Microsoft Word. SideKick, WordPerfect, and WordStar. The emulations don't make Sprint look like each different word processor, since the screen design and the position and style of the menus remain Sprint's. But the emulations do provide familiar commands for word processor

MEDIUM INSTRUCTIONS

Sprint You can even tailor your own interface by writing your own menu tree or by assigning function keys, Ctrl keys, and

users making the switch to |

Alt keys as shortcuts for menu command sequences. Users thinking of switching

to Sprint will also applaud its file conversion features. Sprint

Alt-F Alt-L Alt-S

ends appear on pull-down menus. The menu shown here lets you select a menu tree for Microsoft Word, WordPerfect, or another supported package.

HANDS-ON INDEX

25-MHz 386 FACE-OFF IBM PS/2 Model 70-A21 . 35 ALR FlexCache 25386 Compaq Deskpro 386/25...36

Hertz 386/25 PARADOX 05/2

Powerful protected-mode

HANDY SCANNER HS-2000 \$299 hand scanner for line at continuous images 46 IBM 3363 OPTICAL DISK DRIVE

200MB write-once drive .. 46 SEIKO CM-1430 COLOR

Sharper, less expensive than IBM's 8514......46

CRYSTALPRINT WP Low-cost alternative to lase printers 54

WORLDPORT 2400 Shirt-pocket modem..... 54

PAGEPERFECT

Integrates word processing, deskton publishing56

Sprint

ontinued from page 33)

boasts bidirectional file conversion with DisplayWrite 4 (DCA RFT), Microsoft Word, Multi-Mate, MultiMate Advantage, Wang (IWP), WordPerfect 4.2, WordStar, and WordStar 2000.

Wordshar, and Wordshar, 2009. In another key selling point, Sprint sports an optional autosave feature that writes everything in memory to disk as you work—without detracting significantly from system performance. If your system losses power for any reason, Sprint will automatically rebuil devery file you had open when you lost power. Whether you trip over your power cord or turn off your machine by mistake, you machine by mistake, you endnotes.

The cross-referencing feature is particularly valuable and unusual: you can reference tables, figures, and text by assigning variable names; Sprint will resolve those names into the appropriate table, figure, or page

numbers at print time.

The program sports other features that are more charactersitic of a page composition system than a word processor. You
can reserve space (in inches,
centimeters, picas, or lines) for
art to be dropped in after printing, and you can specify horizontal skips in ems and ens, as
well as inches, centimeters, picas, and character-s. You can
also build in a character-ranalation table to that quotes, dashes.

a midrange performer in that area, but scrolling from the top to the bottom of a large file in

Sprint is nearly instantaneous.

Paging through a file is also very fast. If you hold the mouse at the top of the screen, for example, the file zips by almost too quickly to be useful.

So much for good news. The down side of Sprint is that it's not very WYSIWYG. Justified text is actually justified of text is actually justified on screen, and type styles and sizes are shown using various colors. But centered and flush-right paragraphs are displayed ragged right, just the way you type them.

Fortunately, there's a print preview option, so you can get a formatted view of your file without resorting to hard copy.

without resorting to hard copy. Borland says the non-WYSIWYG style of Sprint is an acceptable trade-off for faster screen performance. Those who take advantage of Sprint's more-powerful formatting features may buy that argument, but for more-conventional word processing, the lack of interactivity seems primitive. It's too easy to wipe out a formatting code accidentally or to enter one incorrectly in the first place.

Moreover, while Sprint offern a form of style-sheet capability, it's much less easy to use than one might wish. The various formatting codes you can use in a Sprint file are linked to a default style-sheet file. To change the way a code behaves, or to define a new code, you can modify the style-sheet file (or create a new one and invoke it with a Style command at the top of your document). This approach to style-sheet generation

25-MHz PCs (continued from page 33)

386/25's performance, while graphics-intensive users will probably head for the Compaq

Destgno 380/25.
With performance differences as small as these, however, your choice should depend as much on cost, disk capacity, and other particular features that are important to you. And don't forget the bus standard. IBM's 25-MHz Model 70 can hold its own performancewise against any of the competition, so tit may be time to begin considering whether MCA is the right

path to take with your next pur-

Whichever 25-MHz 80386

chase

winds up as your choice, make sure your wallet is well stocked before you head out to buy. These machines sell for about the price of a new sedan; buying two of them is the equivalent of a down payment on your next house.

But if it's speed you're after

requires the user to learn what amounts to a document-oriented programming language; it's likely to be well beyond the reach of nontechnical office workers.

workers.

Sprint offers a lot for its price tag. It should appeal particularly to those who need a flexible interface and to advanced users who want to proposition systems. But those who've grown accustomed to a more WYSIWYG screen may want to think twice.



long as you're running with the autosave feature invoked. In addition, even if you exit

Sprint properly, you need not close files. Sprint automatically saves each file and returns you to the same set of open files and editing state when you restart

the program.

While the flexible front end is Sprint's most marketable attribute, its most important one—for a certain class of user, at least—is its power at the back end. Those who prepare technical manuals and other complex multifile documents will appreciate such capabilities as automatic indexing, table generation (contents and figures), nestable last generation bulleted), cross-referencing, and, of course, rotontotes and

matically converted to the appropriate values for, say, a Post-Script typesetting device. The editor has some attrac-

tive conveniences, too. You can search and replace virtually anything and take advantage of a full complement of wildcard options. You can define glossary items and macros. For ease of navigation, you can set up to nine place markers in a file. Moses support and a thessuras are there as well, and the spelling checker has a real-time option that works unobtrusively on fasts hardware.

When it comes to speed, Sprint shines in some areas and delivers respectable performance in others. Our global search-and-replace performance tests showed Sprint to be

FACT FILE

Sprint Borland International Inc 1800 Greenhills Dr. Scotts Valley, CA 95066 (408) 439-1060

List Price: \$199.95 Requires: 384K RAM, two disk drives, DOS 2.0 or later Hard disk recommended. In Short: A powerful word processor that features emulation interfaces and bidirectional file conversion for a handful of popular word processors. Lack of WYSIWYG display is its only serious flaw. Not copy protected.

CIPCLE 441 ON READER SERVICE CARD

IBM's 25-MHz Model 70 Tops Compag via Static RAM Cache

BY JOHN DICKINSON

IBM Corp.'s previous 386sed PS/2 models have lagged behind the speed leaders, primari-

ly because of Big Blue's failure to adopt a static RAM memory cache. Not only does the 25-MHz IBM PS/2 Model 70-A21 move near the front of the pack by curing that shortcoming, but it does so in a remarkably small

Sporting a footprint of only 235 square inches, the Model 70-A21 builds on the twodecked interior design of the original Model 50. The tiny, multilayer system board contains the A21's MCA (Micro Channel architecture) control circuitry, three MCA expansion slots, a VGA display adapter, as

well as serial, parallel, and mouse ports. A daughterboard holds the A21's 25-MHz 80386 microprocessor, 64K static RAM cache, 82385 cache controller, and optional 80387 numeric coprocessor.

Like the Model 50, the Model 70 mounts a plastic I/O "deck" above the system board. The A21's deck accommodates up to two 31/2-inch 1.44MB microfloppy drives and one 120MB, 25-millisecond hard disk. The hard disk's ESDI controller is built in, and all disks tap into the system board through a T-shaped circuit card.

Up to 8MB of 80-nanosecond system memory, mounted in 2MB SIMMs, can be attached to the system board. You can also add up to 8MB of additional RAM on a single MCA expansion card that IBM announced when the Model 70 was introduced.

System performance is far from a problem with the A21. The only machine that beats its 2.25-second performance on the PC Labs 80386 Instruction Mix benchmark test is ALR's FlexCache 25386, and the difference is slight. The same goes for the memory tests. The A21's disk drive perfor-



Model 70-A21 sports merely three expan sion slots, sacrificing expandability for a small Model 50-like footbrint.

mance, on the other hand, could stand improvement. Out of the four systems we review here,

the A21's disk clocked the slowest performance on the small-record test and the second slowest on the large-record test. You'd expect more from a machine so fast in other respects, and so costly, but the disk subsystem is still fast compared with non-ESDI alternatives.

The only serious deficiencies of this new PS/2 machine are its lack of a large hard disk option and its paltry supply of expansion slots. The maximum disk size of 120MB may be a problem for storage-intensive applications. And three expansion slots just won't cut it for power users who want to hook their 25-MHz 386-powered graphics workstations up to a LAN, a CD-ROM, and a main-



IBM PS/2 Model 70-A21 IBM Com. Contact your local authorized IBM dealer. List Price: \$11,295, with 25-MHz processor, 2MB RAM, 120MB ESDI hard disk In Short: With only three slots the unit may pose an expandability problem for some users. Overall, this PS/2 offers tre-

mendous performance in an in-

genious, compact design.

CROLE 439 ON BEADER SERVICE CAR frame-and then add an 8514 display adapter to the mix.

But a limitation for one buyer is an advantage for another. If you want big processing power but not big size, the IBM PS/2 Model 70-A21 is just what you're looking for. You just can't get more computer in less

Proprietary Caching, Fast RAM Put ALR FlexCache 25386 on Top

BY MITT JONES Brace yourself:

the sun still rises in the east, Republicans still scorn welfare programs, and Billy Martin still has trouble holding a job-but Compaq no

longer makes the fastest PC around. Advanced Logic Research now earns top honors with its ALR FlexCache 25386. The secret behind the Flex-

Cache's speed is enhanced memory performance via a 64K 25-nanosecond static RAM cache, a proprietary cache controller, and system memory composed entirely of 32-bit, 60ns. dynamic RAM. The Compaq Deskpro 386/25 and the IBM Model 70-A21 use 100-ns. and 80-ns. dynamic RAM, respectively. ALR claims its pro-

prietary cache control-

ler-coupled with the faster DRAM-eliminates the onewait-state penalty normally suffered as the result of a cache miss.

Whatever the reason, the results are impressive. Our evaluation unit consistently took top honors in the PC Labs 80386 Instruction Mix and Conventional Memory benchmark tests. Despite its respectable but not field-leading hard disk performance and slow

video performance, the ALR FlexCache 25386 led the

Now the fastest PC on the marker, the ALR FlexCache 25386 holds nee full-height and three half-height internal drives in its large chassis.

pack on the PC Labs 1-2-3 performance tests, even without its video BIOS shadowed in RAM. What does the fastest machine money can buy have to of-(continues on page 36)



Compaq Deskpro 386/25 Adds Up to 1,500MB Disk Capacity

mance.

but the

PC Labs

perfor-

mance

the

test showed

FlexCache

advantage overall.

able to maintain a slight speed

Yes, it's true-Compaq is

no longer the Speed King. With

that said, the Deskpro 386/25

should remain a top choice

among users who need power to

spare. The speed differences

among the machines we tested

are small, and the Deskpro's

rugged design, generous op-

tions, and proven compatibility

ety of I/O options than you'll

Compaq offers a wider vari-

remain strong selling points.

1-2-3

BY MITT JONES



If you liked the Compaq Deskpro 386/20, you'll like the Deskpro 386/25 about 5 MHz

about 5 MHz more. Aside from the new 25-MHz processor, the 386/25 changes little of the Deskpro

386/20 design.
The 386/25 is based on the same Flex Architecture, which keeps the peripherals bus at a safe 8 MHz but provides a 32-bit memory bus running at full clock speed. All system memory—up to 16MB of 100-nano-second DRAM—resides on one proprietary memory expansion board, along with a 32K, 25-ns. static RAM cache and Intel 22385 cache controller.

While this design gave the Deskpro 386/20 a performance edge over the IBM Model 80 and other competitors, the aggressive 25-MHz entries from IBM and Advanced Logic Research leave the Deskpro 386/25 behind, if only slightly.

The PC Labs benchmark tests place the 386/25 behind both the IBM Model 70-A21 and the ALR FlexCache 25386 on processor- and memory-intensive tasks. The Deskpro partially makes up for its somewhat

taily makes up to its somewhat and to lack user memory speed with field-leading hard disk and video perfor-

pro parblessing if you're determined mewhat not to spoil the continuity of the textured black system front panel. A standard 5%-inch high-

density floppy disk

External exponsion units
permit the Compaq Deskpro 386/25 to be outfitted
with up to 1,500MB of hard
disk capacity. In ad-

permit the Compact Deskpro 38625 to be outsitted with up to 1,500MB of hard disk capacity. In addition, the nevest Deskpro sports a new keyboard with a clacker feel than previous keyboards.

drive occupies one of the four front-accessible drive bays; a 110 MB, 25-millisecond or 300 MB, 20-ms. ESDI drive occupies the other, depending on the configuration you choose. The other two bays make from

for the optional Irwin-made tape drive and 1.44 MB 3½-inch floppy disk drive. In a move that's sure to make the 386/25 a favorite for the network server position, Compaq is offering 1,200MB of additional disk capacity via external expansion units. Each unit will FACT

Compaq Deskpro 386/25 Compaq Computer Corp. 20555 FM 149

Houston, TX 77070 (713) 370-0670

List Price: Model 110, with 110MB hard disk, \$10,299; Model 300, with 300MB hard disk, \$13,299; Expansion Box, with 300MB hard disk, \$6,999; additional 300MB hard disk.

In Short: 25-MHz performance in a well-built box that leaves plenty of room for growth.

CIRCLE 437 DN READER SERVICE CARD

hold two 300MB drives. Two units can be attached to one system, allowing as much as 1,500MB hard disk capacity. The 386/25's 'industry

standard" peripherals bus (as Compaq terms it) accommodates XT- and AT-compatible expansion boards via six 16-bit slots. Standard equipment includes one parallel port, one serial port, a clock/calendar, and a 220-watt power supply.

Compaq no longer has the fastest PC money can buy. But the Deskpro 386/25 is a near-irresistible choice when expandability, compatibility, and dependability matter.

ALR FlexCache (continued from page 35) fer besides speed? Just about

anything you want-except, of course, Micro Channel architecture.

The ALR FlexCache's tower chassis holds two full-height and three half-height internal drives. The base configuration loads one full-height bay with a 150MB ESDI drive; a 300MB model is also available. A 1.2MB flooppy disk drive occupies one of the half-height bays. ALR also offers optional 1.44MB microfloppy disk drives and 150MB backup tape drives.

The system board includes 2MB of DRAM, expandable to 14MB with an optional proprictary memory expansion board. Like the Compaq, the ALR FlexCache plugs the memory board into a proprietary 32-bit slot. The standard peripherals bus includes two 8-bit slots, four 16-bit slots, and two 32-bit

The ALR FlexCache uses the Phoenix BlOS and ships with a copy of Phoenix Technology's Control 386. Control 386 allows menu access to several system parameters and provides enhancements such as a disk cache that can be set up in RAM. You can also shadow the video and system BlOS into fast RAM, an option you'll definite by want to take advantage of in

order to tweak the most perfor-

mance out of the system.

The steel chassis itself is large and heavy, an advantage in you appreciate solid design but a disadvantage if you're in the habit of toting your computer across the office. The unit's technical specifications set its weight at "100 pounds maximum"; our evaluation unit

weighed closer to 75 pounds. The best new about the ALR FlexCache is its price. At 93,499 with a 150MB and disk and VGA adapter, the ALR FlexCache is not only the fastest of the four machines reviewed here, it's also the least expensive. Assuming money, performance, and quality count, the ALR FlexCache deserves a serious look.



ALR FlexCache 25386 Advanced Logic Research Inc 9401 Jernimo Irvine, CA 92718 (714) 581-6770

List Price: Model 150 (with 2MB RAM, 16-bit VGA card, 150MB hard disk), 59,499; Model 300 (with 2MB RAM, 16-bit VGA card, 300MB hard disk), \$12,499. In Short: Both the fastest and

the least-expensive 25-MHz machine reviewed here.

E 434 ON READER SERVI

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Hertz 386/25: Intel's Top Box

BY JOHN DICKINSON



If you're expecting a joke about rent-a-car computers, forget it-this Hertz isn't a car, and, like all 25-MHz 80386-based

PCs, its performance is no joke. Hertz's newest PC is based on Intel's 25-MHz 386 system board and cabinet. You'll probably get very familiar with the look of this cabinet, because that's the only way Intel is providing 25-MHz 386 systems to

its OEM customers. OEMs can equip the system unit with whatever peripherals they want. The chassis has one full-beight and three half-beight tape or disk drive bays, and the system board has one 8-bit, five 16-bit, and two 32-bit expansion slots. The 32-bit slots run at CPU speed for memory, but any other AT-compatible card will

run in the other 8-MHz slots. The memory configuration can also vary in both design and 285:75 mm chine is based on the Intel 25 MH: system beard

system to work with static-col-

umn, interleaved page mode or

with cached direct random ac-

cess memory designs. The static

RAM cache is configured with

64K of 30-nanosecond static

RAM fed by a custom-built con-

troller that was developed be-

fore the 25-MHz version of the

installed on the system board in

Up to 8MB of RAM can be

82385 was available

board can support up to

24MB of RAM by adding cards in its special 32-bit memory slots. The Hertz 386/25

configuration comes standard with 2MB of cached RAM: our evaluation unit had 4MB. It also had a

320MB, 16-millisecond, ESDIcontrolled hard disk made by Maxstor. The standard disk offering is a 72MB model, and a 150MB

model is also available. One parallel and two serial ports are standard, as is one 1.2MB floppy disk and an 8-bit Paradise VGA display adapter and a monitor to go with it. Hertz is one of the few PC vendors that give you a choice of the new 101-key or the older configuration 83-key keyboard on a 386

The Hertz/Intel is definitely not the leader of the 25-MHz



Hertz 386/25 Hertz Computer Corp. 325 Fifth Ave.

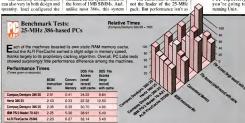
New York, NY 10016 (212) 684-4141 List Price: \$11,995 with 72MB hard disk: \$13,995 with 150MB hard disk; \$15,995 with 320MB hand disk

In Short: Herry's 25, MHz en. try is built solidly, performs well, and can be configured with up to 24MB for Unix us-

CIRCLE 436 ON READER SERVICE CARD

much of a problem as price-at \$11,995 for the base model, it's not exactly a steal, although substantial discounts are available to customers buying in quantity. Perhaps more important than either issue, the Hertz 386/25 is a rock-steady machine. Don't pass it over when you shop for your next power

PC, especially if you're going to be running Unix. 26



The 80386 instruction Mix benchmark test measures the intensive tasks. The test program uses 80386 instruction code. These instructions era e subset of the total

referents e number of 32-bit operations. In the 80386 processor these become single instructions, whereas in

The Conventional Memory benchmark test elecates 256K of conventional memory and treats it as a series of 54-byte records. Then, 16,394 rendom records are read into and written from this memory. The result shown is the

The DOS File Access benchmark less measures the throughput rate of the disk being tested in this case. roughput times are meesured in terms of how long the disk takes to perform common DOS file-menagement sequential file reed, random file write, and rendom file

processing and spreadsheet files. Loading a DOS program is also simulated by the large-record tax If no dieli caching software is supplied by the co or disk drive manufacturer, each test is run once «« Data Guardian »»

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you in aways know when it stime to optimize again.

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ust as the gas shortage of |

the mid-'70s alerted

Americans to their dependence

on foreign oil, the current scar-

city of DRAM chips has awak-

ened the domestic PC commu-

nity to its dependence on an im-

ported resource: Japanese-

made DRAM chips.

Within the past half year, the supply of

DRAM chips

Fifth Generation Systems Inc.

Carbon Copy Pius Meridian Technology Inc.

Turbo Pascal 4.0 and International Inc.

has fallen far short of U.S. de-

mand, and DRAM prices have

risen to damagingly high levels.

on more DRAM, we would be a

much larger company in terms

of revenue," says a Sun Mi-

crosystems spokesman. "The

principal constraint we are under is a shortage of DRAM not

The exorbitant prices systems manufacturers must pay for the DRAM they manage to

obtain hurts manufacturers and

buyers alike. While a number of systems manufacturers have passed the higher DRAM

costs along to the end user for both config-

ured systems and

expansion

a shortage of business."

"If we could get our hands

Rankings are based on net sales by unit: returns are subtracted from gross sales

business programs according to their sales performance in the last week of a 5week period. It also tracks programs' rankines (reading left to right) from May 16 through June 18. A 5-week history is charted to give a sense of a program's sales strength over time. Dramatic shifts in a particular program's ranking may be the result of sales promotions conducted by individual retailers. Seasonal factors such as end-of-year-budget purchase decisions, can also play a large role in the performance of a particular program in any period.

More than 12,000 individual locations contribute to the list.

Sales information compiled by Ingram Software Inc. and PC Connection Inc.



IN PERSPECTIVE The Top Ten Sellers list ranks PC

The DRAM Shortage: A Chronology

1983 Explosion in PC sales outstrips DRAM supply, contributing to rise in DRAM prices.

PC rate of growth softens, and new DRAM production capacity begins to come on-line. Result: overcapacity, lower prices.





DRAM prices tumble amid massive oversupply and Japanese dumping in U.S. market. American DRAM manufacturers fold or suffer major



U.S. and Japan agree on FMV arrangement for DRAMs, but Japanese parts remain available at below FMV on gray market. American manufacturers continue to suffer losses



losses.

RAM, many would-be buyers are delaying their purchases until prices fall. Fifteen percent of the respondents to a recent PC MagNet survey reported plans to put off purchases until DRAM prices fall to acceptable levels

These developments could hardly have been more poorly timed, since the continued development of the PC seems dependent on a ready supply of reasonably priced RAM. OS/2 with the Presentation Manager requires a minimum of 5MB RAM, and this requirement shows no signs of getting any smaller.

The Crisis: Blow by Blow
The large, unexpected demand for PCs in 1983 is where
the story begins, according to
Andrew Kessler, a Paine
Webber securities analyst who

the story begins, according to Andrew Kessler, a Paine Webber securities analyst who tracks semiconductor trends. The memory chip industry was unable to supply the burgeoning PC market, and memory prices rose. This prompted plans for considerable new-chip capacity both in the United States and

PC demand softened around the end of 1984, just as massive new memory-chip capacity was coming on-line, and an overcapacity condition soon developed. Oversupply put pressure on memory prices, which tumbled in 1985. Prices for 64K parts plummeted from roughly \$3 to a low of 30 cents, and 256K prices fell just as drastically.

their way into the United States on the gray market, according to Mr. Kessler, and Japanese chips remained available at well below FMV levels.

Further U.S. pressure prompted Japanese government

Within the past half year, the supply of DRAM chips has fallen far short of U.S. demand, and DRAM prices have risen to damagingly high levels.

Japanese firms, bardened by massive overexpacity, were cited for dumping in the U.S. market by the Commerce Department in 1986. That dumping generally is blamed for the collapse of the U.S. DRAM industry; only Micron Industries and TI remain as major players in the memory chip business. IBM is widely acknowledged to be the world's largest DRAM producer, but its entire output is decicated to internal uses.

In July of 1986, an agreement was reached between the United States and Japan's semiconductor industries to maintain chip prices at a fair market value in the United States. But Japanese parts continued to find intervention to physically cut production in order to ward off retaliatory action. As fabrication lines were taken off-line, prices rose and the shortfalls began to

develop.

A Semiconductor Productr/ User Group, chaired by 3 Com CEO William Kraus, has focused on the FMV as a major causative factor in the RAM shortage. The complex pricing arrangements impose different FMV levels on each Japanese producer, creating a tangle of unforeseen effects. The semiconductor group has recently prepared and submitted a report to Commerce Secretary Verity, suggesting, channess that will

stimulate a rise in chip availabil-

ity. Those proposals are not yet public.

Technology also plays a role. The industry migration from production of 2-56K parts to production of I-megabit parts has also constrained supply. The shift to the higher-density parts means a shift away from 2-56K RAMs, which further limits supply of the still widely used memory.

Therein lies some hope, hower. One-megabit yields are already rising, and analysts say that this can only help the supply situation. Mr. Kessler cites a prediction that I-megabit output will double between the second and fourth quarter of 1988. "That will satisfy a lot of demand." he points out.

Mending the Market When will DRAM prices re-

turn to tolerable levels? The solution to the problem won't be a magic buller that suddenly restores balance and reasonable pricing. But rising availability of I-megabit chips will belp, as will the imposition of a more conducive FMV agreement with Japanese producers. A "Iwo DRAM price" item on your Christmas wish list shouldn't be far off the mark.

-Jonathan Matzkin

1987
As DRAM demand reaches new heights, Japanese decree production cuts to ward off U.S. retaliation, and manufacturers begin tooling for 1-megabit chip production.
American manufacturers unable to fill the void.
Combination results in drastic undersupply of 256k chips at elevated prices.



1988
DRAM prices continue to rise amid growing demand and inadequate supply, Manufacturers begin ramping up production of 1-megabit chips.





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Paradox OS/2: A Good Reason to Buy OS/2

PC HANDS ON

BY RICHARD HALF SHAW Borland International has come up with the first good reason to stray from DOS-Paradax OS/2. The latest incarnation of Paradax is more than an OS/2 version of the powerful relational DRMS that received PC Magazine's Editor's Choice ("Programmable Databases: dBASE and Its Challengers, PC Magazine, May 17, 1988). It's a multitasking database management system that takes complete advantage of OS/2's protected mode and returns more performance, power, and flexibility than any of its DOS-

based predecessors or rivals. With Paradax OS/2, you can perform all of the mundane aspects of database management (sorting, querving, indexing, adding, changing, and deleting records) on the same data at the same time, via multiple OS/2 sessions or as part of a multithreaded Paradox application. You can even write your own distributed applications in which different Paradax sessions communicate and pass data to each other and to other PCs running Paradox on a net-

Running Paradox OS/2 is a

cinch. The package retains the personality of its DOS predecessors, with point-and-shoot menus, the PAL applications development language, and the Personal Programmer applica-

tions generator. PAL applications can use the new Session command to "snawn" additional Paradox sessions and perform other jobs (such as sorting a table or printing a report) as background tasks, while continuing to use the full facilities of Paradox in the foreground. Since Paradox OS/2's code is completely reentrant, only the first session actually loads the program into memory; subsequent sessions share the same program code. And a command-line parameter can control the amount of the

memory used by each session for managing files and tables. Paradax's built-in file- and record-locking facilities and data concurrency mechanisms originated in the DOS version of the product. While these are invoked transparently, commands are available to access them directly. And if another Paradax OS/2 session or another Paradox user on a network changes a record or row that you are viewing, your screen will be undated to reflect the differences auto-

matically. All of this ensures

that you can sort and modify tables, debug and run PAL scripts, print reports, and run whole applications in different sessions on the same set of data tables simultaneously.

As Charles Petzold has warned in his PC Magazine Environments column, an anplication that abuses OS/2's resources will slow down a foreground process as additional instances of the application are added in the background. In an effort to study this. I ran nearly a dozen different Paradax sessions. I was not able to perceive any difference in the performance of any of the foreground applications, regardless of the number of Paradax sessions that were running in the background.

Borland promises that Paradax OS/2 will not be lacking in future enhancements. The Borland Turbo languages will be able to access the Paradox Engine, allowing users of Turbo C and Turbo Pascal to write applications that can read/modify Paradox tables. In addition, interfaces to the various OS/2 SOL (Structured Ouery Language) servers will be made available as these appear in the

marketplace.



Paradox OS/2 Borland Internation 4585 Scotts Valley Dr. P.O. Box 66001 Scotts Valley, CA 95066-001 (408) 438-8400 List Price: \$725

Requires: OS/2 Standard or Extended Edition 1.x. a 286- or 386-compatible PC, 3MB RAM, one hard disk and one high-density 51/4- or 31/2-inch floppy disk drive. In Short: A relational DBMS

that takes full advantage of OS/2's multitasking capabilities. Includes an easy-to-use interface, a powerful programming language, automatic fileand record-locking, and fully reentrant code.

ORCLE 440 ON READER SERVICE CARD

the wait. If you're looking for a multitasking relational database environment that takes advantage of OS/2's vastly superior facilities now, you can't lose with Paradax OS/2

Benchmark Tests: Paradox OS/2 vs. Paradox 2.0

Paradox OS/2 turned in a mixed performance compared with its DOS counterpart. However, the tests were designed for the DOS environment and show Paradox OS/2 at its worst. Running multiple threads of execution and in multiple OS/2 sessions, Paradox OS/2 could perform all the tests simultaneously with little or no performance degradation. All tests were performed on a 50,000-record file

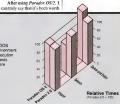
Performance Times

	Import	Search	Delete and Index
Paradox OS:2	2,859.25	258.29	3,939.90
Paradox 2.0	2.831.10	376.40	3.346.60

comma-delimited format) with an index on the tirst held. We include the indexing portion of the lest to

require a two-step process for this test, an import folio The Search test measures the time it takes to locate the first record that satisfies two onterio (make - Fendh) and

The Delete and Index (four-column version) test



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FIRST LOOKS

Northgate Power 386: Premium Performance at a Bargain Price

PC HANDS ON

BY BILL O'BRIEN Field-leading 386 performance just got cheaper. Northgate Computer Systems' Power 386 rivals the power of the Compaq Deskpro 386/20 at a fraction of

The Power 386 is an upright. 20-MHz floor model with a base price of \$4,295-including a high-performance 65MB hard disk

A 64K static RAM memory cache deserves much of the credit for the Power 386's performance. Like the Deskpro 386/20, the Power 386 maintains a high-speed, 32-bit path to memory, separate from the I/O hus

Whereas the 386/20 makes use of Intel's sophisticated cache controller chip, however, the Power 386 falls back on a direct-map static RAM system composed of discrete logic components. Compaq's solution no doubt earns it memory

Steve Gibson, InfoWorld, 3/21/88

the top, along with a disk activity light. Inside are eight slots. speed at which the information

The hard disk drive does not have an overly spectacular track-to-track access time-28 milliseconds-but that is a mechanical measurement of disk capability. Data throughput, the

access performance gains in some cases, but the Power 386 won't be far behind.

is actually passed across the bus and the more important measure performance, rates as spectacular

when hard disk caching is enabled. But even without caching, the largeand small-record times for the

benchmark tests rank the Power 386 machine right up there with the

Compaq Deskpro 386/20. The standard configuration includes a 14-inch monochrome monitor, one 51/4-inch 1.2MB floppy disk drive, and one 31/2inch I .44MB floppy drive. That

leaves you with one empty halfheight bay. Whether you purchase

© PC Mag., July 1988, 2017-Decis Co.

FACT

Northgate Power 386 Northgate Computer Systems 13895 Industrial Park Blvd... #110 Plymouth, MN 55441

List Price: With IMB DRAM. 64K SRAM cache, one 51/4-inch 1.2MB floppy disk drive, one 31/2-inch 1.44MB floppy disk drive, 65MB hard disk, monochrome monitor, \$4,295 In Short: The Power 386 delivers top performance and intelligent design at an excellent price.

be disappointed. Watch Microsoft Windows load quickly for a change, or observe a pull-down menu snap up like a runaway window shade, and you will finally get an honest feel of what speed is all about. *NOTE: Reprinted in fa without editing, to give you the complete picts

this 386-based machine for its

price tag or for its performance,

the chances are that you won't

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\$299 Handy Scan Provides Line Art and Continuous-Tone Images for the Masses



BY TOM STANTON Who needs a \$299 hand-held graphics scanner, with 200-dotper-inch resolution? The answer may be quite a few of us. Desktop units offer better resolution and a larger scanning area, but even with prices starting at \$900, they remain out of reach

for more-casual users. The Handy Scanner HS-2000, from DF1, answers the needs of amateur publishers. designers, artists, and graphics enthusiasts. The HS-2000 offers a midtech solution that includes line art and continuoustone images. The hand-held scanner is well constructed, simple to install, and easy to

The package I tested included a copy of Halo DPE, a popular graphics/paint program from Media Cybernetics, but the HS-2000 also comes with a scanning interface from DF1. The HS-2000 has a 4-inch

scanning array activated by a roller that controls the scanning speed and minimizes lateral motion. A window over the roller helps you position the scanner to fit the image within the array. The handle contains a switch to select image type (halftone or

line) and a contrast dial. Scanning with Halo DPE software is simple: you highlight the scanning icon and hold



inch scanning area. A window lets you view the paper image as you scan it.

age. The HS-2000 scans a fairly large area this way, but I found it difficult to control scanning

speeds on longer stretches. DFI offers more-modest scanning software that allows bit editing and image cropping. Best of all, DFI software supports several graphics file formats, including Z-Soft's PC Paintbrush Plus (.PCX), Microsoft Windows Paint (MSP). GEM Draw (.IMG), and Dr.

Halo (.CUT) The HS-2000 does an acceptable job scanning continuous-tone images like photographs. Line-art scanning was generally quite good.

The .PCX format proved troublesome when I used PC Paintbrush Plus. On a CGA monochrome system the DFI file blanked the screen; on an EGA color system the .PCX file loaded correctly but turned the screen a deep blue. By adjusting the palette on the EGA I could



Handy Scanner HS-2000

11 Harts Ln., Suite P East Brunswick, NJ 08816 (201) 390-2815 List Price: \$299 (includes Halo

Requires: One half-card slot. Hard disk recommended In Short: An inexpensive, feature-laden hand-held scanner. CIRCLE 431 ON READER SERVICE CARS

eliminate the blueing, but the image converted to yellow instead of black. DFI never fully explained why this problem occurred, except for some vague reference to incompatibility with earlier versions of PC Paintbrush.

Overall, the DFI HS-2000 is a good value for the right application. Professional publishers will probably demand better than a 200-dpi scanner, but for others, the \$299 price represents a bargain.

IBM's 200MB Write-Once Optical Drive

HANDS ON

BY CRAIG L. STARK The IBM 3363 Ontical Disk Drive is Big Blue's attempt to popularize the write-once, readmostly (WORM) technology, a technology that everyone seems to admire but few seem to buy.

Early WORM drives came with software that only a backer could love. IBM's first smart design move with the 3363 was to make the WORM drive seem like just another hard disk. You address the 3363 as you would any other disk drive; you can use DIR, COPY, DEL, MKDIR, and other DOS filehandling commands. Indeed, you can even run most executable programs from the 3363. though its obvious use is to store data files. Despite its 200MB capacity, the 3363 needs no internal partitions and has no 32MB-file-size limitation. A few new commands are needed to maximize the advantages of a WORM device, and IBM's second smart move was to put these in two menu-driven utility programs that require lit-

tle user learning. You can also enter the commands from the DOS command line. Since WORMs are particularly suitable for maintaining an unalterable "audit trail" of successive revisions of a single file, the 3363 lets you store multiple versions of the same filename in the same directory.

overwritten unless you issue the new ERADICATE command. The 3363's second set of utility programs lets you back up and restore multidirectory disks, changed files only (with optional date criterion), or files from an easily generated list (with or without file compres-

Older, inactive versions are not

sion). Specific inactive versions can be accessed, and no DOS RESTORE pass is required.

The 3363 reads sequential records only about a quarter as fast as my 85-ms. hard disk drive. Writing was even slower. I backed up 29MB (1.613 files in 55 directories) onto an Irwin 745 tape in one-seventh the time it took the 3363. However, because of the unit's linked-file storage format (which also saves disk storage space), sub-

sequent incremental backups-backups of only data that has changed-onto the 3363 would be much less time-con-Moreover, you don't buy a WORM for speed, but for the

reassuring impermeability of its laser-written records. The 3363 itself is a model of solid construction and shielding-which is reflected in its \$2,950 price. Conventional FACT FILE

IBM 3363 Optical Disk Drive IBM Corp. Contact your local authorized IBM dealer

List Price: Optical Disk Drive: external, \$2,950; internal, \$2,700; 200MB cartridge, \$65. Requires; IBM PC AT, XT, PS/2, or computible: DOS 3.2

In Short: A top-quality WORM optical drive that provides 200MB of storage per removable cartridge.

CIRCLE 435 ON READER SERVICE CAR

or later

hard drives are a less expensive way to store the first 200MB. But with additional 200MB removable cartridges at \$65 each, even the cost per megabyte for secure, head-crash-immune storage quickly tilts in favor of the optical media.





Wait for Ashton-Tate to get their SOL act together In the meantime, just sit here and watch the ORACLE players pass you by. Or order Professional

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- 6 If it isn't in ORACLE, it probably un't in anything else, either . For
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- ORACLE will crunch data until your eyes roll back in your head Infoworld, April 1968
 - powerful, Professional ORACLE is an excellent choice for application developers.

Winner Editor's Cho PC Magazine, May 1988 program of choice for those who want sophisticated forms, reports, and SOL capabilities without baving to program extensively." oftware Orgest Ratings Report divanced Relational Dalabase

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Seiko CM-1430 Monitor: A Sharper, Less-Expensive Alternative to IBM 8514 Display

HANDS ON

BY CHARLES PETZOLD There's no question about it: the PS/2 color monitors are disappointing, with washed-out colors and a background that looks gray in comparison with the deep black I had come to expect from IBM displays. The best of 1BM's PS/2 monitors is the 8514 (designed to support the 1,024 by 768 resolution of the 8514/A video adapter), but it costs \$1,550 and still doesn't

deliver a first-rate picture.

14-inch 8512 at \$250 and the tiny 12-inch 8513 at \$595) don't even come close.

The CM-1430 is built around a Sony Trinitron CRT with a .26mm dot pitch. The case is roughly the same size as IBM's g514 display. The on/off switch is at the back, and the brightness control is at the lower-right corner in front. There is no contrast control. At 14 inches diagonally, the CM-1430 has a smaller tube than IBM's 15inch \$514 monitor. The visible area of the CM-1430 tube is closer to 13 inches (14 inches ier characters that stand out a little more

But switch to a VGA graphics environment, and the CM-1430 really shows its stuff. The black-on-white text contrast is superb. The colors are sharp, crisp, and rich with high contrast and definition. The IBM PS/2 monitors (even the 8514) always look a little out of focus. The Seiko does not. The deep black background that's characteristic of IBM's earlier CGA and EGA color monitors is absent on its PS/2 monitors. The

CM-1430 brings it back. For 8514/A graphics, the advantages of the Seiko CM-1430 over IBM's \$514 display are not quite as obvious. When colors of nearly the same hue are displayed, they are slightly more differentiated on the 8514 display than on the CM-1430. However, the Seiko monitor

still delivers the sharper image. Personally, 1'd prefer a larger monitor for the 8514/A in order to get more text on the screen while keeping the text characters a readable size. IBM's 8514 monitor displays 1,024 by 768 graphics at about 100 dots per inch; the Seiko's smaller screen increases that to about 110 dpi. I'd rather see 8514/A graphics displayed with FACT FILE

Seiko CM-1430 Color Monitor

Seiko Instruments USA Graphic Devices and Systems

1130 Ringwood Ct. San Jose, CA 95131 (408) 943-9100 List Price: \$995 Regulres: VGA or 8514/A vid-

In Short: The 14-inch Seiko CM-1430 is compatible with the IBM 8514 monitor at two-thirds the price and with a superior picture for color graphics. While more expensive than IBM's two VGA-only color displays (the 8512 and 8513), it's well worth

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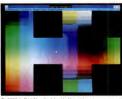
the extra cost

For anyone contemplating the move up to the 8514, the CM-1430 can help. It reduces the total cost of 8514 graphics from \$3.110 to \$2.555—definitely a step in the right direction. Even if you intend to run only VGA graphics, the extra cost above the IBM 8512 or 8513 monitor is well worth it.

In a VGA graphics environment, the CM-1430 really shows its stuff. The black-on-white text contrast is superb. The colors are sharp and rich with high contrast and definition.

Seiko Instruments USA's CM-1430 is the first monitor from a manufacturer other than IBM that is designed for compatibility with both the VGA and 8514/A adapters. Very simply, it's a better monitor than any of IBM's PS/2 color displays. The two VGA-only color monitors from IBM (the grainy

for the 8514), and the video image is about 12 inches diagonally (131/2 inches for the 8514). You may prefer the IBM PS/2 monitors for plain old white-on-black text modes. The CM-1430 image is so sharp that you can see the scan lines, and the characters seem a little light. The IBM monitors display fuzz-





The \$995 Seiko CM-1430 monitor (left), with a 26-dox pitch, produces a sharper, crisper image than IBM's 8514 monitor (right), although the 8514 upholds IBM's reputation for truer colors. Each monitor was photographed displaying a PC Labs 85 14/A graphics screen under Microsoft Windows



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MapInfo Integrates Maps with Databases

MapInfo Corp. is selling a 5750 software package of the same name that displays and analyzes maps linked to its own database data, or to that of existing BBASE or other third-party databases. MapInfo sells 300 MetroMaps (of metropolitan regions), BuralMaps (of rural regions), BuralMaps (of rural regions), BuralMaps (of rural reamp) prices vary from \$95 to \$2,000.

The program uses database information to create 'pin maps' and 'thematic maps.' The former feature lets you put points on a map at designated addresses and store accessible data records for each address point. The latter enables you to

them, and store records pertaining to them.

You can locate a data point at any street address, search the database for points within specified boundaries, call up a window that displays the data record attached to a point or region, or find the latitude and longit tude of any point on the map.

MapInfo can accept Auto-CAD metafiles for embedding architectural detail into maps, and the program outputs desktop publishing for page work requiring map illustrations.

List Price: Maplafo, \$750.

Requires: 640K RAM, hard disk, drive, DOS 2.0 or later. dBASE III or similar reconsumended. Not copy protected. Maplafo Corp., 200

Broadway, Troy, NY 12180; (800) 327-8627.

CIRCLE 446 ON READER SERVICE CARD



Maplatio (\$750) creates "thematic" and "pin maps" that link locations to the program's database information or to third-pury databases.

Sycero db: Database Application Generator Uses Clipper, FoxBASE

PC Publishing has announced Sycero db, a dBASE program generator that works in tandem with Clipper or FoxBASE.

The \$495 program generator transparently generates code for screen processing, reports, and overlays. With it you can link an unlimited number of database in systems composed of pro-

grams containing up to 30 databases each.

In addition, Sycero db offers 16 commands not found in 16 BASE. It also automatically calls Clipper and produces documentation for the DBMS. A screen painter offers color popup menus, screen overlays, and manual or automatic field secuencine.

Up to 300 lines of dBASE, Clipper, or Swerre code can be added to each field. No retrofitting is required when using independently written dBASE or C routines. And Sycero maintains added code even if you generate a program more than once to change it.

List Price: Sycero db, \$495; network version, \$695. Requires: 512K RAM, hard disk drive, DOS

512K RAM, hard disk drive, DOS 3.1. Not copy protected. PC Publishing Inc., 1801 Avenue of

the Stars, Los Angeles, CA 90067; (213) 556-3630.

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Expansion Boards Add Ports to Your PS/2s

search have augmented their product lines with new boards that give Micro Channel PS/2s extra serial and parallel ports. Boca's \$210 Boca.MCA Serity Parallel furnishes two serial ports and one parallel port.

STB is offering two boards: the \$239 Serial 2 with two serial ports, and the \$259 Serial/Parallel 2 with both a serial and a par-

(continued on page 52)

Wells American CompuStar System Solves The Micro Channel vs. AT Bus Dilemma

If you're in a quandary over whether to switch to a Micro

whether to switch to a Micro Channel system or stick with your known-quantity AT bus, Wells American Corp. may have the solution. Its new CompuStar system can be configured with 13 AT slots, 10 PS/2 slots, or dual buses that offer 7 AT slots and 5 PS/2 slots.

The chameleonlike system also by our hose one of four microprocessors (8008, 80286, 80286, 803865X, or 803865X, or 803865X, or 803865X, or more street, and the current offerings already run at industry-high speeds of 20 and 25 MHz, and they can access 16MB of RAM.

The machines have room for six front-mounted disk or tape drives and one full-height internal drive.

All permutations of the CompuStar system will be equipped with one parallel port, two serial ports, a mouse port, a keyboard, EGA and VGA ports, a disk controller, and a 220-watt power supply.

List Price: Wells American CompuStar (base system: 10-MHz 8086, 512K RAM), 5995. Wells American Corp., 3243 Sunset Blvd., W. Columbia, SC 29169, (803) 796-7800.

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<u>\$</u>

The CompuStar from Wells American offers three different combinations of We to United to A Librarian Louisian also change microprocessors.

NEW ON THE MARKET

PS/2 Roards (continued from page 51)

allel port. The STB boards are compatible with IBM's Dual Async Adapter/A, are programmable, and support assignable reserved interrents List Price; Boca, MCA Serial/Pa-

rallel, \$210. Requires; IBM PS/2 or compatible. Boca Research, 6401 Congress Ave., Boca Raton. FL 33487-2841; (407) 997-6227. CIRCLE 448 ON READER SERVICE CAR



The \$210 Born MCA Ser sal Parallel board (above) and the \$239 STB Serial 2 board (left) furnish additronal ports for Micro Channel PS/2 machines

List Price: STB Serial 2, \$239: Serial/Parallel 2, \$259. Requires: IBM PS/2 or compatible. STB Systems Inc., 1651 N. Glenville #210. Richardson, TX 75085; (214) 234-8750.

CIRCLE 449 ON READER SERVICE CARD

Hummingbird Browser Sends dBASE Data to Other Applications

Berkeley-based software house Cauldron has released Hummingbird Browser, a \$99 RAMresident program for use with dBASE. Cauldron was founded by Charles Chou, creator of the first dRASE compiler

HB*Browser's main funcons are to transfer dBASE data to sereadsheets and word processors and to give TSR access to data files. It is 100 percent compatible with dBASE data and index files and uses pulldown menus and pop-up win-

HB*Browser saves users from having to quit the application in use, call up dBASE, and save data to a new file that would then be imported to the application in question after that has been called up again. Cauldron says this will make users less hesitant to keep databases up to date.

HB*Browser lets you open up to ten files at a time, each with multiple indexes, in resizable windows.

List Price: Hummingbird (HB+) Browser, \$99. Requires: 256K RAM, one disk drive, dBASE, DOS 2.0 or later. Not copy protected. Cauldron, 3204 Adeline St. Berkeley, CA 94703; (415) 654 3361

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First Erasable Optical Mass-Storage System Arrives from AGA

Advanced Graphic Applieations promises a November shipment date for its Discus Rewritable-an erasable optical

mass-storage system Tandy has announced an erasable CD-ROM disk, but a system based on that product is not expected for at least a year. The Discus Rewritable plugand-play optical disk drive. which is not CD-ROM compatible, uses AGA's device drivers and SCSI adapter, 51/4-inch op-

tical disks from 3M, and a disk drive from Olympus The included device drivers will offer an OS/2 version of the device drivers as well. The company is offering the drivers for licensing to other erasable optical drive makers, hoping to establish a standard interface.

The AGADrive SCSI Host Adapter used with the system takes up one PC expansion slot. An included disk can hold 650MB of data. Additional

disks cost \$250 each. List Price: Discus Rewritable. \$4,995, Advanced Graphic Applications, 90 Fifth Ave., New York, NY 10011-7696: (212) 337-



the first database management system supplier to offer its own compiler and symbolic debugget, R:base Compiler.

Slated for release this fall. the compiler/debugger will work in DOS, OS/2, and R:base System V versions, and with applications created in Application Express, R:base's program generator. The compiler supports applications that use the 80287 coprocessor and LIM EMS. It outputs nonoverlay code by default or overlay code if your memory requirements demand it.

Statements in compiled R:base programs run 10 to 15 times as fast as in interpreted

mode The compiler supplies extensions to the R:base language. For example, limits on WHILE statements are removed, and user-defined functions written in R:base, C, or MASM are mable The symbolic debugger in-

cluded with R:base Compiler is

menu driven, with source code

in one window and debug in an-

other. It runs in continuous

mode or single-step mode, or

with changeable break points.

You can access both DOS and

database while debugging.

List Price: R:base Compiler, call

company. Requires: 512K RAM;

hard disk drive; DOS 2.1 or later

(single-user version), DOS 3.1 or

later (multiuser). Not copy

protected. Microrim Inc., 3925 159th Ave. NE. Redmond, WA 98052: (206) 885-2000 CIRCLE 444 ON READER SERVICE CARO

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Ouestion: What do you get when you cross the soul of a daisy wheel with the latest in pageprinter technology? Answer: A personal text-only printer of outstanding value. The \$1,399 CrystalPrint WP, from Oume Corp., could put the final nail in the daisy wheel's well-sealed coffin. It's fast, it's quiet, and it produces gorgeous letter-quality output.

Like the daisy wheel before it, the CrystalPrint is a tool for people who place a premium on high-quality text and whose printing needs don't include graphics. The daisy wheel's legacy is further evident in the Diablo emulation that comes standard on the Crystal Print.

The similarities end there. The CrystalPrint is a page printer like the laser printers that have hogged the spotlight recently. A photosensitive drum, with a rated life of 10,000 pages 15.7 inches (HWD) the CrystalPrint WP will take up even less of your desk space than the compact HP Laurelet Series II printer, which mea super in at 8 hr 17 5



and a \$129 replacement cost, applies the image to the paper using toner dispensed from a separate toner unit. The \$99 toner unit carries a lifetime rating of 6,000 pages. Instead of a laser, though, the CrystalPrint uses liquid crystal technology to

The CrystalPrint's output is very close to the excellent print that you expect from a laser. Close scrutiny of text printed on duplicator paper reveals some minor feathering, but the print quality is easily good enough for even the most important reports and correspondence. Speed is another virtue that

generate the page image.

you expect from a page printer. The CrystalPrint, while not as fast as Hewlett-Packard's LaserJet, skims along at a respectable 5.8 pages per minute.

A number of options allow you to upgrade the CrystalPrint if your printing needs grow beyond the capacity of the barebones system. Emulations of the IBM Proprinter and the Epson FX series come in plug-in cartridges, and HP Laserlet emulation can be obtained with an upgrade of the CrystalPrint's ROM (not user-installable). The emulations cost \$79 each



CrystalPrint WP Quine Corp. 500 Yosemite Dr. Milpitas, CA 95035 (408) 942-4000 List Price: \$1,399 In Short: An inexpensive afternative to conventional laser

printers for personal letter-CIRCLE 430 ON READER SERVICE CARD

quality output

and require an additional 128K RAM board that costs \$169. All three emulations include

graphics, but the HP emulation is limited to 1/4-page graphics. This is quite sufficient for the needs of most users, provided no major desktop publishing

ventures are contemplated. Not least among the Crystal-Print's virtues are its compact dimensions: 9.1 by 13.4 by 15.7

inches (HWD). If what you need is fast, sharp, quiet text output, you will have a hard time finding a better answer than the Crystal-Print WP.

Worldport 2400: Speaker and Indicator Lights in a Shirt-Pocket-Sized Modem

HANDS ON BY HOWARD MARKS

The biggest problem with shirtpocket-sized modems has been their lack of a speaker for monitoring calls. Touchbase Systems has managed to shoehorn a speaker into its latest laptopminded modem-the Worldport 2400. Like its highly acclaimed, 1,200-bit-per-second sibling, the Worldport 2400 also boasts LEDs for Call Progress, Carrier Detect, High Speed, and Low Battery.

Shirt-pocket modems have several advantages over the more conventional internal modem. They can move with you as you upgrade to the latest machines or fill in as a backup for your home modem. They also leave your expansion slots free, and since they sport their own batteries, they won't drain your laptop's.

The Worldport normally turns itself on when your PC initializes the serial port during boot-up. To prolong battery life, a switch allows you to set the modern to turn on only when your PC asserts DTR (data terminal ready)-usually just before your communications program dials.

You also get an adapter for Radio Shack's acoustic cups. for those times when a phone iack just isn't available. World travelers will appreciate support of the CCITT V.22 1.200-bns

modulation scheme that's used in many European countries.

To top it all off, Touchbase throws in a copy of Meridian Technology's Carbon Copy Plus communications and remote-console software. Besides its well-known remote-control features, the program's general communications functions are a



The Worldnort 2400 macks the fe of a full-rize modern into a 1- by 2%- by 4-inch (HWD) case.

FACT FILE

> Worldport 2400 Touchhase Systems Inc. 160 Laurel Ave. Northport, NY 11768 (516) 261-0423 List Price: \$359; upgrade from Worldport 1200, \$199. In Short: Touchbase tops its Worldport 1200 pocket-sized

modem with a 2,400-bit-persecond model that even includes a speaker. CIRCLE 433 ON READER SERVICE CARD

step up from the software that many modem makers supply. The Worldport 2400 has

earned its permanent place in my travel bag. Its small size, speed, Hayes compatibility, and, of course, speaker hav made it indispensable.

Why Paradox 2.0 makes your network run like clockwork



Paradox* runs smoothly, intelligently and so transparently that multiple users can access the same data at the same time—without being aware of each other or getting in each other's way.

With Paradox news travels fast and it's always accurate

Paradox automatically updates itself with a screen-refresh that ensures that all the data is up to date and accurate all the time. Record-locking, Paradox-style, asfeguards data integrity by preventing for example, two different users from making changes to the same record at the same time.

To run Paradox 2 0 or the Paradox Network P.

- Novel with Novel Advanced Helware version 2.0A or higher
 3Com 3Plus with 3Com 3+ operating system version 1.0, 1.1
- or higher

 IBM Token Ring or PC Network with IBM PC Local Area Networ Program version 1 12 or higher
- Torus Tapestry version 1.45 or higher
 Af&1 Sartan version 1.1 or higher
 Banyan VMSS version 2.10
 Other network configurations that are 100% comp
 3.1 and one of the limited sedworks.
- System Requirements for the Natural Workstell © DOS 31 or higher
- Any combination of hard, floppy, or no disk drives
 Compatible monochrome, color, or EGA monitor with adu

does not perform a accordance with our cleans, call our business service department on all arrange a refuel.

Produce is negligarized scanness in Area Schware Ansa is a Dertend Helenwistonic Company Other Invasid and syndact reases are registered basinessis or Maldership of the respective feature. Service 30 to 20 to 10 to

believe it. Here was a true network application, a program that can actually take advantage of a network to provide more features and functions, things that can't be done with a standalone PC.

Agron Brenner, LAN Magazine

With Version 2.0, Paradox becomes a sophisticated multiuser product that boasts an impressive selection of dataproduction features and passwordsecurity levels.

Rusel DeMaria, PC Week 99

Paradox responds instantly to "Query-by-Example"

The method you use to ask questions is called Query-by-Example. Instead of spending time figuring out how to do the query, you simply give Paradox an example of the results you're looking for. Paradox picks up the example and automatically seeks the fastest way of getting the answer.

Queries are flexible and interactive, And in Paradox, unlike in other databases, it's just as simple to query more than one table as it is to query one.

66 The program elegantly handles all the chores of a multiuser database system with little or no effort by network users.

Mark Cook and Steve King. Data Based Advisor 99 PC database managers ... Paradox still reigns supreme as the thinking user's DBMS.

Jim Seymour, PC Magazine 99

You don't have to be a genius to use Paradox

Even if you're a beginner, Paradox is the only relational database manager that you can take out of the box and begin using right away.

begin using right away.

Because Paradox is driven by the serouse Paradox is driven by the very latest in artificial intelligence technology, it does almost everything for you—except table tiself out of the box. (if you've ever used 1-2-3° or off-8-5° you already know low low off-8-5° you are lowed when the paradox for Lous Users' and "A oluck Gulde to Paradox for Lous your network work.") Paradox, it makes your network work.

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BY JONATHAN MATZKIN AND LAURIE WANCE PagePerfect, from IMSI, integrates full-featured word processing and document management with traditional desktop publishing features. The result

is a well-rounded \$495 publishing system aimed at users who need more power than low-end DTP packages can muster but who can't invest the time and effort required to learn the highend alternatives. PagePerfect is primarily

keyboard driven. There is mouse support, but mostly for minor functions like scrolling through menu choices and positioning a document on-screen. One of PagePerfect's main

selling points is its full wordprocessing capability. In word processing mode, it does indeed offer all of the usual characterattribute and formatting capabilities. That's a welcome relief to anyone who has ever tried to key text into several of the hetter-known DTP packages.

However, the look of the text is not easy on the eyes. Onscreen characters appear rough and fragmented. This word processor wouldn't win any races, either. Our test system, a 20-MHz 386 machine, has power to spare, but I was easily able to type ahead of PagePerfect | also place and size gutters. while entering text

Both of these shortcomings are due to PagePerfect's running entirely in graphics mode, with the attendant penalties in speed and text resolution. To IMSI's credit, the company

The program also has stylesheet capabilities, which set it

well apart from low-end packages. You can specify paragraph and page styles for all the pages of a document before you begin to flow text into it.

porapost come FORTS make

PagePerfect's opening screen displays a tree-directory diagram of your hard disk; the files contained in the highlighted directory are listed in the lower right section. An onscreen templote shows the PagaParfact commands and the keys they are mapped to.

specifies a 286 PC as the minimum configuration that will properly run the software.

PagePerfect supports the sophisticated page-layout techniques that separate true desktop publishers from glorified word processors. You can specify the number and size of columns on a page, and you can

Placing and sizing images is a relatively straightforward opcration, but PagePerfect is limited in its graphics support. The program includes Hala DPE and supports graphics only in the file format generated by Halo. However, a standalone utility-Reflections (\$89)-is FACT

PagePerfect

1299 Fourth St San Rafael, CA 94901 (415) 454-7101

List Price: \$495 Requires: 640K RAM, 80286 or 80386-based PC, EGA or VGA graphics, one high-densi

ty floppy disk drive and a hard disk. DOS 2.0 or later In Short: A total DTP solution complete with integrated word

processing and style sheets. Not copy protected. CIRCLE 434 ON READER SERVICE CARD

graphics formats into a form

that PagePerfect can use. There is currently no support

for encapsulated PostScript files. IMSI says that PostScript support will be included in subsequent releases of the package.

PagePerfect is a good choice for those who want a complete environment in which they can create attractive memos, newsletters, reports, and other DTP projects of intermediate complexity. The included word processor probably wouldn't cut it as a standalone tool, but it's fine for its intended use. If your needs exceed the simplest packages and you tremble at the thought of the more powerful stuff, PagePerfect may be just what you want.

Lotus Value Pack Zaps 1-2-3 Copy Protection

HANDS ON

BY DONALD B. TRIVETTE My mother always told me I couldn't get something for nothing, but she was wrong, Value Pack, from Lotus Development Corp., has seven "somethings" and costs nothing. Lotus is giving Value Pack to dealers and encouraging them to pass it along free to you, though there are reports of some dealers selling it. If your favorite dealer doesn't have Value Pack, you can order it directly from Lotus for \$15, to cover handling and

Value Pack has seven features, the most important of which may be Lotus's official mechanism to remove copy protection from Lotus 1-2-3. After you run this program, you'll never again have to fool with a keydisk. You also get 6 months of

available for conversion of most

premium, toll-free telephone support from Lotus technicians. Sounds too good to be true, but it works. An ID number included with Value Pack and a special toll-free telephone number get you to a customer-support person fast. In less than 2 minutes I had my questions answeed

The other values in Value Pack are new drivers to support VGA, 43-line EGA, and Post-Script printers: a speedup feature that allows you to recalculate only the cells you've changed; and a keystroke recorder that makes writing 1-2-3 macros easier.

Despite the wait for 1-2-3, Release 3.0, it looks as if Lotus really wants to remain your spreadsheet company.

List Price: Value Pack, free from dealers; \$15 postage and handling from Lotus, Requires: Lotus 1-2-3, Release 2.0 or 2.1. Lotus

Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142; (617) 577-8500

CIRCLE 429 ON READER SERVICE CARD

SideKick Plus Gives Your PC the Power of Communication!



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SideKick Pius saves you time and keystrokes with sample scripts for popular programs like MCIº Mail, Compu-Serve, and BiX. You can create scripts by simply recording your keystrokes, or edit scripts to access the full power of the script language.

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CIRCLE 137 ON READER SERVICE CARD

44 The built-in communications program is very impressive . . . Unitike most communications programs (including some that cost twice as much as SideKick), the new SideKick lets your computer

communicate with another machine while you are running another program. -Lawrence Magid, Washington Post 99

Get the power!

To buy this kind of communication power and all the other SideKick Pius features separately, you'd spend hundreds of dollars and drain your computer's memory dry. Instead, just see your Borland dealer and get the power of SideKick Pius!

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of learning speed. We have.

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PC UPDATE

by Paula Seefeldt

Ca/Session Adds Voice Design

Triton Technologies has incorporated Voice Design into its remote-access package, Co/Session. Voice Design allows users to begin a remote-support session with a phone call, eliminating the need for a separate data line. A twouser Co/Session license is \$249, which includes one support and one application license. Additional application and support licenses are \$125 and \$175, respectively. Triton Technologies Inc., Red Bank, N.J.; (201) 741-3232.

Signal, the financial information service from Lotus, now includes Mutual Fund and Money Market data. Version 2.0 also offers the Mid-America exchange and the Chicago Board of Trade Market Profile service. To further in-



Signal now in-

crease coverage, Signal has added 60 new indexes, including AMEX and NASDAQ, with support for 1,250 stock symbols. Signal users may upgrade for \$55. New packages retail for \$595. Lotus Development Corp., Cambridge, Mass.; (617) 577-8500.

Faxes with PS/2

Quadram's facsimile board is now compatible with the IBM PS/2 Micro Channel. The JT Fax PS/O allows the Micro Channel-compatible computer to act as a Group III-compatible fax machine. No ASCII conversion is required. Files are changed directly into fax format and then sent. The JT Fax PS/O will ship in the fourth quarter of the year and will retail for \$595. Quadram Corp., Norcross, Ga.; (404) 923-6666.

The Norton les 1.2.3 And dRASE File Viewers

The Norton Commander, the IBM DOS enhancement shell and file manager, now allows browsing of Lotus 1-2-3 and dBASE files without leaving The Commander, Version 2.0 also adds an asynchronous File Find and a pulldown menu interface. The Norton Commander, Version 2.0, retails for \$89. Peter Norton Computing, Santa Munica, Calif. (213) 453 2361

Ventura Offers Free Upgrade

Registered users of Ventura Publisher, Ver sion 1.1, will receive a free upgrade from Xerox. This enhancement is designed to allow Ventura to run under Microsoft Windows and to import files from other Windows applications. The update also includes revised Hewlett-Packard LaserJet printer drivers and the ability to store HP LaserJet fonts in a Ventura subdirectory. Xerox Corp., Rochester, N.Y.; (800) 822-8221

WordStar 2000 Adds LAN Capabilities

MicroPro International has added LAN compatibility to its WordStar 2000, Version 3. Network support uses file locking to enable multiple users to access and edit files in the same directory. Upgrades from Release 2 LAN are \$149 with new packages retailing for \$695. MicroPro International Corp., San Rafael, Calif.; (415) 499-1200.

Spark Adds lard Disk

Datavue Corp. has redesigned its Spark laptop computer to include a 40MB hard disk drive. Weighing in at less than 10 pounds, the new Spark retails for \$2,499. Current users of the Spark floppy-disk-drive-based laptop can purchase a factory upgrade to the hard disk for \$1,249. Datavue Corp., Norcross, Ga.; (404) 564-5668.

Bac Software Revises Accounting Series

Dac Software's Accounting Series offers several new features, including pull-down menu interfaces and a RAM-resident utility with file viewing. Series 3.0 includes Dac Easy Accounting 3.0, Dac Easy Payroll 3.0, Dac Fasy Granh+Mate, Dac Fasy Accounting Video Tutor, and Dac Easy Accounting and



All transaction entry screens can be reached through pulldown menus.

Payroll Tutors. Accounting retails for \$99.95. Payroll and Graph + Mate are each \$99.95, and the Video Tutor is \$49.95. The Accounting and Payroll Tutors are each \$29.95. Upgrades for current users are \$35, except for the Accounting and Payroll Tutors, which are \$15. Dec Software, Dallas, Tex : (214) 248-0305.

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-From God's Game, by Andrew M. Greeley (Warner Books, 1986).



Graphics tip: print your release right side up. (National Computer Graphics Association press release.)

Or the New 68088?

"Takashima, director of systems product marketing, claims that Televidoc can come up with new products faster and fill gaps in the major companies' product lines. 'If they offer a machine based on [Intel's] 80286 processor, we'd come out with one based on [Motorola's] 8088 chip, 'he says."

—High Technology Business, July 1988 (brackets are
the magazine's)

One Group Showers More

"Basic Base has the speed and power of 4GL in the BASIC you know and love. Basic Base is used by both people and programmers in database applications."

-Application Micro Computers Inc. ad



Like the oil says, the Deskpro 386 is available now (subject only to availability). (PC Computer Rensal, New York Circ.)

OS/2: Just Say No

"Nearly everyone agrees that DOS lacks many standard operating-system features—multitasking, large address space, multiuser support, realtime capacity, increased memory, graphics and communications support, and applications availability. But then, neither does OS/2."

-Table of contents, PC Tech Journal, January 1988

Does It Cost Another \$3,000 if There's a Shutout?

According to The Boston Globe, the National Hockey League computer system balked when Neil Sheehy was traded to the Hartford Whalers and switched from jersey number 5 to number 0. Reprogramming to accept a zero set the NHL back \$3,000.

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They Do It?

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-PC Direct (San Francis-

So That's How They Do It

A newspaper ad for Scot Business Systems of Cincinnationses Systems of Cincinnation offers a two-floppy-disk-drive Leading Edge Model D for \$1,095 with "free DS Tutor (learn competers & software), Leading Edge Word Processor [and] choice of 1200B modem, Microsoft Mouse or Masterpiece power director." Or you can buy the "2 floppy system minus freebies—5995."



Cabling anyone could understand: complete setup instructions for this Black Box perspheral reads, "Connect the Data Contester IC 1/0 to the printer as shown."

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Winners this issue: Steve Gordon (cabling simplified), Tom Comerford (NCGA press relense), David Omension (subject to availability), Jody Weisrbaum (neither docs OSC), Leoreso Simulia (God S Gorne), Elhan Winer (people and programmers), David Rearn (Identrolac high, Thomas O'Haro Jr. (PC Direct), William Connally (Silfo Irreliers, Peter Dausit (MR)).



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Inventor and entrepreneur Dick Erett explains how "The Activator" provides sane protection for your intellectual property.

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GETTING CEOs TO **USE PCs**



Executives are a small percentage of the people using computers. Why, then, are we focusing so much attention on their informational needs?

xecutives, by and large, don't use computers. The few who do are sought out, hounded, and extolled by computer journalists, and held in fear and suspicion by their peers. Their use of computers is a testament to their tenacity and courage. Given the state of the art, it's a wonder that they get anything useful out of them. New hardware and software products, however, could finally put the personal computer into the executive suite in a big way

Personal Information Managers are still too new for people to be entirely comfortable referring to them as PIMs. Yet their emergence, coupled with the rising popularity of decision support systems, creates a new class of software: the Executive Information System. EISs can't be defined neatly or classified by what they do. If they are to be at all successful, they must be highly adaptable to the preferences and styles of the executives they serve.

Executives in financial service companies need systems that put them in touch with volatile worldwide currency, stock, and commodities markets. Manufacturing executives need a window into the performance of various manufacturing lines, inventory levels, orders, and shipments. Even the mundane balance sheet is ripe for exploitation. Every number is backed up by hundreds, perhaps thousands, of other numbers. The executive should have access to all of them. Through a technique known as drill-down, every number on a spreadsheet can be the access path to the spreadsheet, account, or group totals that it comprises. Each of these numbers, in turn,

can be drilled down to show the underlying figures that created them.

PROBLEMS APLENTY Let's take a closer look at the executive's information needs. We've seen three disparate examples, but they all have something in common: a need for ease of use. We've all heard about keyboard-phobic executives: they've certainly been at the receiving end of criticism from us keyboard-literate types. Our desire for them to become keyboard literate is well-intentioned, but the pressure has only served to widen the gap between users and nonusers. Most applications have gotten more feature-rich and complex. Very few programs have gotten easier to use. Also, computers give decision makers entirely too much information. You know people whom you hesitate to ask "How are you?" for fear that they might tell you. Computers are like that.

Ralph Larsen is vice chairman of John-



son and Johnson, the international pharmaceutical giant. Larsen makes J&J a challenging place to work for infocenter people, because he's highly aware of what the computer can and should do. Larsen's goal is to reduce paperwork by 30 to 40 percent. He charges the information systems staff with taking the lead in telling executives what they have to know to get at the information they need.

"I want to spend my time building the business," says Larsen, "not hunting for information. Today's systems sap our creativity and energy.

Larsen elaborates on his ideal system: "I want something that works like the dashboard of my car. When things are normal, it's not telling me much. When things start to go wrong, I want to know about them. I need to know what the problem is so I can take corrective action.

Larsen's dream system sounds doable, even straightforward. In the real world, it's actually quite difficult to achieve.

Let's assume that your financial and manufacturing systems are already computerized. Fine. Now all you have to do is get the systems to talk to one another. Your accounting system is batch and closes monthly. Your manufacturing system has a bunch of RS-232 bar code readers, time clocks, and terminals feeding some venerable minicomputer. Inventory is running on a spiffy new LAN, and your financial planners are massaging their spreadsheets on individual PCs. Worse, there are no real-world interfaces to tell you when or why a critical machine or process stops. Every gizmo stamped out by your produc-

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tion line passes the scrutiny of a photocell, but all it does is prevent the catch bin at the end of the line from overflowing. You'd be lucky if it tells you how many items you're making per hour. And none of these systems interconnects.

Reference points such as timebases and dates are missing from many of these systems, so even if you could find out what happened, you might not be able to tell when. Add the complexity of remote manufacturing and distribution sites, and a farflung sales force, and you've got a worldclass data collection job.

Connectivity products can overcome the problem of disparate machines and software, but it takes some serious interface programming to make it work. Today's top-of-the-line PCs are the ideal platform for an EIS. You need the power and flexibility of a multitasking environment to manage all the tasks that an executive requires. No one, however, is doing the work to make the executive workstation a reality in the next 12 months.

NECESSARY EFFORT It's absolutely critical that we do these Executive Information Systems. Right now, white-collar America is about 20 percent computerized. That satisfies the 80-to-20 rule and takes care of the early adopters. The next 20 percent won't be all that tough if sales forecasts just stay the same. But getting

over 50 percent will take some doing. In the last 4 years, software has gotten more powerful, but no easier to use. Executives won't put up with that, and neither will lots of other users who don't perceive the need or are unwilling to go through the learning curve. Graphical user interfaces are supposed to make it all better, and they certainly help. Features like consistent command structures and point-and-click operations are essential to reach a whole class of potential users, but we need much more. Hewlett-Packard's New Wave holds real promise, because as an object-oriented superset of Windows, it allows you to hook programs together and perform computations and analysis based on the values and nature of the data it encounters.

The promise of such systems is one thing, putting them to work another. If you're not planning the solution today, you'll be part of the problem tomorrow. 22



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SELLING SIZZLE WITH THE STEAK



Why are state-of-the-art, higher-performance computers stuck with unexciting names and bland color schemes? When will the manufacturers stop casting them in the IBM mold?

ess than a decade ago, it was unthinkable among floppy disk makders that a diskette be any color besides black. If you showed them the oddball blue diskette from Nashua and suggested colored diskettes, they'd always say, "Yeah, I guess we could make them in color, but why bother?" Then you'd suggest that the potential income from premium-priced colorful disks is reason enough-but even if extra profits weren't realized, at least it would make the business more lively. At that point they'd roll their eyes and moan. Finally, Centech showed up with an array of colored disks. which were quickly copied by others. Now I can tell my color-coded archival disks from my color-coded data disks. After years of lazy marketing, someone finally did it. Why did this take so long?

Poor merchandising. It's worse with the manufacturers of the machines themselves. Their marketeers have to be the laziest and most conservative sheep in the marketing world. It's only been over the past year or so that clone makers have had the guts to design an exterior box that isn't a copy of the IBM design. This despite the success of the old Leading Edge Model D made in Korea by Daewoo and designed to look different. We haven't even seen color options for the boxes, despite the fact that a designer in California is making a fortune custom-painting machines. Do the marketing types ever read books on merchandising? Do they realize that offices are colorcoordinated nowadays? Obviously not, So we see beige, beige, and more beige in the same old clone box.

And what about the psychology of these computers? Few makers ever consider the names of their machines. Someone needs to learn a lesson from the automakers and liven things up a bit. I mean, we have the 386 this and the 286 that, and that's it.

NO JOY NO DULLSVILLE. What a dull world it would be if can were named with the same conventions! We'd have a Ford Six, a Chevy Four, a Buick Six, an Olfst-mobile Six. While the German and Japanese use of numbers for cars just' much better (with 3002X, 405SL, 750li, and other meaningless appellations), don't you think Mustarga and Corvette Stimpton and Cortent Stimpton Code State St

It's no coincidence that today's boring marketing man drives a BMW 325 and not a vintage hemi-head Plymouth Fury. With this Germanic nonexistent-merchandising theory in mind, it's no coincidence that the



new Sun Workstation is dubbed the 386i. Give me a break! Maybe they should give away a pair of Reebok tennis shoes, Vuarnet sunglasses, a case of Corona beer, and a How to Be a Yuppie book with the thing. I'm reminded of Bill Machrone's initial

In memmete or bit Macincroes intuits impression of the first Compag 386 released to a world unfamiliar with the new chip. "It's a rocket ship." he said. Now that's a name. The Compag Rocket 386, "Beople When asked what computer you own, ou could say, "I own a Rockat 386!" People like to own a Wildace or a Bronco or a Metoor—why not a Rockat? Instead we get a Deskpro. Ught A name for wimps. Only a gay named Petry would brag about owning a Deskpro.

Today's high-performance machines need names that reflect the power. Everex is off-base with its "Step-386." Step? it means nothing. But at least they named it something other than "386." Vendex, a hot newcomer, has the right idea with the Vendex Headstart, and Zenith is getting close with its SuperPort portables. Better examples are the Core ATomizer, the HP Vectra, and the VIPC Colossus.

What about the rest of the gang? How about an Acer Pacer, a Dell Demon 386-25, a PC Designs Butt-Kicker, an SIA Jetstream, a Zenith Starfire, a Bentley Continental, a Televideo Tornado, a Fivestar 286 Falcon, a Whole Earth Momma, an AST superbee, a SUN Stunner? This is easy to do, folks.

Add colors and new box designs to these machines and you'll be looking at the future of personal computing. I'd advise the manufacturers to take heed and get with it.

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INSIDE TRACK

Memory prices and good ideas all fly high.

We know that the rising popularity of the 32-bit computers as well as memory-hogging operating systems and bloated word processors that all require more and more RAM is exacerbating the worsening memory shortage. One can now expect to pay \$400 or more per megabyte. While this is cheap compared with 1967 memory prices, we should be paying \$40 per megabyte now-and someday pay only a dollar or two. More than a few old-timers have pointed out that our current dilemma is not dissimilar to the one experienced by the mainframers back when MVS was introduced as a memory-hogging operating system. One cynic on the PC Magazine staff says that everything in today's micro market is based on the old IBM ploy to sell more hardware by luring people into newer, fancier, and more inefficient software systems.

Whatever the case, most sivvy observers say we should begin to think of 16 megabytes as a basic system requirement. You heard me right—16 50,000 to buy that much memory and who wants to recommend that! When memory prices collapse, as they will (hopefully by year's end), that amount of memory about the price of the price of the memory should be less than \$1,000.

While a few will shake their heads at the notion of 16-megabyte minimummemory requirements, we have to look back only a decade to the days when anyone with a micro was considered a showoff if the machine had anything over 32K. Times change.

The Ultimate Portable Dept.: 1 figured that Michael Dell would be the first to produce a "perfect" portable. At last year's PC Expo he indicated that Dell Computer felt it could beat Zenith at its own game. That was almost a year ago.

So far, zip. C'mon, I'm waiting.

This brings me to the latest new laptops, the ones from Mitsubishi. They're beautiful clones of the Toshiba 3100/5100 machines. Unlike the Toshibas, they use a black-and-white LCD display instead of plasma. When I first saw these machines I figured that LCDs were used so the machines could be powered with batteries. I was impressed. Each is just about the same size and weight as the Zenith, and the battery pack even sticks out of the back the way it does on the newest Zenith, making the machines slightly back-heavy. Then I looked again. Whoops. That wasn't a battery. It didn't come off, either. The machine needs AC power. Are these guys kidding? Bring out the hook.

Some Good Ideas Dept.: When you go to consumer or trade shows, you find that one of the most popular giveaways is the sack with the name of some company emblazoned on the side. I was impressed by a bag from Mitac that included company information, and I realized that most bags contain nothing more than a brand name. While this may be a fine idea for Marlboro, it's just plain dumb for today's personal computer industry. This is an industry in which people can't get enough information. So why not put some real information on these sacks? For example, the magazines could put an article or two on their bags-that would give you something to read when you're stuck on a plane or a bus

Tirade Number 538. This brings me to another suggestion. Let's put the documentation where it belongs: on the product. Have you ever put a video card or modem or some other peripheral aside and later decided to use it, only to find that you've lost the documentation? Usually the information you need is the switch settings or some other basics.

Compaq has the right idea with a switchsetting cheat sheet glued to the power supply of its 386-20. Why can't other companies follow its lead and print such information on the back of a circuit card or on the bottom of a modern? The time companies lose answering calls about switch settings would more than pay for the minimal expense of putting some information on the printed circuit boards. End of Tirade San

Genuinely Interesting Software Dept .: If you like simulations, then you'll love the Nimbus collection of genuine video slot machine and video pokor machine games. They only require a CGA-and they make the most of it. There are six disks, which sell for \$19.95 each (plus \$2 shipping per order). If you want to sample these programs, try the Aisle #3 disk, which has my favorite slot machines. If you want a fabulous video poker game, then try the Aisle #6 disk. These are the work of young programmers, and you have to write them for the stuff at Nimbus Enterprises, 415 Crestway Rd., Henderson, NV 89015.

This is superb software because they worked with a slot-machine mechanic to get the "feel" of the video slots (and the odds) absolutely perfect. So perfect that it seems as though this stuff could easily be thrown on a cheap clone in the back room of a sleazy St. Louis bar and actually used for illegal gambling. Because there are 30 complete and different kinds of machines represented on the disks, you quickly see that the investment needed to establish a room full of gaming machines on, say, a boat off the coast of Baja is next to nothing. I sure don't want to get these kids busted for doing a good job, but the first thing I thought of when I played the Aisle #3 disk was how easy it would be to run these games in one of those bars in rural Missouri. When the coppers show up, you swap diskettes and it's Flight Simulator! I expect this to be an interesting trend.

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PS/2s: RELIABILITY COUNT\$



The MCA bus has taken its share of ribbing since IBM introduced the PS/2 line last April, but its design has helped make these machines the most reliable in the business.

hen IBM introduced its new PS/2s almost a year and a half ago, it made some technical claims that, at first blush, seemed pretty grand.

grando. Signest, of course, was for the magic of the Misro Channel architecture (MCA) bus. In arbitrated, multimaster design would make oposible some amazing things, we were told, with several micro processors changing away out there on that bus at the same time. No longer would our PC's—oops, better make that your PS'2's—single Intel 8028/60386 have to PS'2's—single Intel 8028/60386 have to the standard of the MCA bus to handle video processing, bus grand communications, and other bush grand communications, and other

The MCA bus has taken a lot of kidding over the past 16 months. I've had my share of sport with it, calling it "woodoo technology" and "Mystery Channel architecture." Others have been much tougher still on the new design.

Chief among the other IBM promises for the PS/2s was that these were more reliable machines, built better thanks to a more buildable design. And that buildable design, IBM said, made them three or four times more reliable than IBM's first PCs, according to IBM's own testing.

HEATH'S VIEWS Chet Heath was the principal designer of the MCA bus and has been centrally involved with the PS/2s since long before they were called PS/2s. A senior engineer at IBM's Entry Systems

Division in Boca Raton, Chet is a typical IBMer in his competence and self-assurance but a most untypical IBMer in his candor and openness.

He's intensely proud of what he wought in the Micro Channel architecture—and not a little wounded by the sliggs and barts of a skeptical press and wary customers. Che's pride in his design work, and in his colleagues' other achievements in the FSCs, shines through when the talks about the PSCs as business machines built to solve business needs. If that doesn't sound more high and representation of the control wound more high control wound more high control wound more higher talk-ing... well, Chet of the desiry is under the control wound have been a solven and the control wound have been and the control wound have been a solven and the control wound the control wound have been a solven and the solven an

I recently spent a long time talking with Chet about the PS/2s, the MCA bus, and how they've fared in the real world. Not about the number shipped and which distribution channels IBM thinks appropriate for the machines—that's not his ball-

PS/2/MCA has matched the design spec of a more useful, more reliable PC.

Chet has some very interesting views on PC-level systems reliability and, in turn, on how we evaluate PCs in the eighties and beyond. 1'll be writing here occasionally about those views and how they fit with my own (and, I suspect, with many of yours) as we see competitive MCA-bus machines from Tandy, Dell, Kaypro, and others come to market.

One of Chet's most interesting points and one I knew immediately to be true, from my own experience and that of my corporate clients—is that the PS/2s have indeed proved to be much more reliable on the job than their PC, PC-XT, and PC AT predecessors.

Though I've seen a surprisingly large number of new PS/2s come through with right-out-of-the-box problems, indicating poor final testing or, likelier, shipping problems and poor checkout by dealers, once a PS/2 is up and running, it's likely to stay that way for a locong time.

Chet points out that this positive field experience has been reflected in a recent regigering of IBM's on-site service agreement prices. Not only does the PS/2 Model 50 come with a 1-year warranty, but IBM has priced the service agreement at 15th year, as opposed to 5546 per year for the most popular PC AT configuration in business use, the finned Model 339.

PS2 PAYS Chet goes on to calculate the savings in buying a PS/2 Model 50 rather than a Model 339 PC AT. The first year's

JIM SEYMOUR

warranty is free, either way. But during the second, third, and fourth years of ownership, PS/2 buyers will effectively pocket \$366 a year, the difference between a Model 50 service agreement and one for a

Model 339. In addition, of course, you get what amounts to a Video Graphics Array (VGA) adapter built into the motherboard of the PS/2s (excepting the Model 25 and the Model 30), so you save another \$400 or so on the cost of a video board

Add that up and you've "saved" \$1,500 over the probable useful life of the computer by buying a PS/2 over even IBM's own True Blue AT. And Chet finds this a persuasive argument for why PS/2 clones-and soon, he thinks, AT clones from other vendors-will find tough sledding in the marketplace; their real cost is too close to the real thing.

This argument makes some substantial assumptions, of course. First, that you're going to buy a service agreement for either machine. Second, that you consider the PS/2 the functional equivalent of a PC AT. And third, that you buy the idea that the machine really has proven that much more reliable in service.

As I mentioned, in my experience, without exception, the latter case has prov-

 The PS/2s have indeed reliable on the job than their PC, PC-XT, and

proved to be much more PC AT predecessors.

en true: clients with collectively tens of thousands of PS/2s, many now in use for a year or more, have found Model 50s, 60s, and 80s substantially more reliable than the other PCs they've put in over the years, from IBM and other vendors.

And you should remember that even if you consider service agreements lousy ideas, not buying one is in effect self-insuring: if something goes bump in the night, fixing it comes out of your pocket.

The PS/2s' low-cost service agreements, which reflect IBM's confidence in their reliability, should make you feel a little better about their record . . . even if you're as frustrated as I am that the MCA bus, as full of promise as it may be, still hasn't been used to any meaningful extent by commercially available hardware or software products. And thus hardly constitutes a reason to buy one of these newfangled machines.

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COMPUTER LIB: BLAST FROM THE PAST



Ted Nelson's iconoclastic book provides a welcome antidote to eighties complacency perhaps because it was written nearly 15 years ago.

As more and more lies appear around formerly T-shirted necks in a society in which business and financial success have become the only goals worth mentioning, it's grobably to be expected that the most interesting computer software to have crossed my desk in the last forments is, in fact, a book—much of which was originally published in 1974. Coher: (Tempse books/Microsoft Press, \$18.95) is the kind of book that grabs you by the neck and shakes you awake.

Nelson is the man who invented and promoted hypertext (in part via this tome) and has recently been, as he charmingly admits, "promoted from Lunatic to Visionary." His cranky, funny, snide, passionate blast from the past (with copious doses of the present and future) makes everything else you read about computers seem utterly flaccid. While denizens of Planet Reagan complacently mutter platitudes about multitasking and connectivity, this recycled flower-powerist bursts into the room hollering in capital letters that "COMPUTERS ARE JUST AS OP-PRESSIVE AS BEFORE, BUT SMALL-ER AND CHEAPER AND MORE WIDESPREAD." The effect is bracing.

As you might expect from the father of hypertext, this book is not meant to be read straight through. It's a direct countercul-tural descendant of the Whole Earth Catalog, complete with ugly format, digressions, sidebars on every page, and internal scoss-references at every turn. It also uses a hoary science fiction and porn format known as the two-in-one: when you get to

the end of Computer Lib in the middle of the book, you flip it over and read Dream Machines.

LINEAR? NO WAY! Linear organization? Hypertext won't have it, and neither will Nelson. The book's setup is about as logical as a shooping mall. There are a



couple of anchors at both ends—a screed about how lousy computers are and a dream of how much better they could be—but as you wander down the corridors, you can browse through an almost infinite range of items relating to computers and their history.

On one page Nelson will rave about some wacky summer-of-love electronic orgasmotron that later proved to be a pure phony; a couple of pages later he! The denient of he history of commercial robots, including the ones that used to provide entertainment at Choick E. Chees's pizza establishments. One minute you'll be reading about computer mischief; the next, you'll be perusing pithy remarks about the fictitious nature of business plane.

Nelson's long rumination on the history and motives of IBM (whose "fall" he continues to predict, with considerable persuasiveness) is one of those models of historical clearheadedness that so rarely find their way into print. It's like sitting down at a bar with somebody who says, "Forget all the mealymouthed garbage you've heard: I'll tell you what's really going on!" and then goes off on a well-documented rant for the next hour. It may not all be exactly as told, but as an antidote to the official gloss it certainly is refreshing. Nelson also includes capsule histories of most of the computer companies and languages you've heard of-and many that have gone the way of ALGOL.

FORCE AND RANGE Most remarkable about this book is the sheer force and range of Nelson's interests. He cares deeply

STEPHEN MANES

about people who use computers and simply refuses to abandon them to the whims of computer makers.

With the paranoia of a true child of the sixties, Nelson basically distrusts organi-

zations, be they governmental or corporate. His noble concern for textual integrity—making sure that what you write isn't later emended in your name by some faceless government or corporate bureau-

crat—brings up a nasty issue rarely mentioned elsewhere. His long discussion of the nature of electronic encryption and the repression of public discussion about it—including speculation about the postbility that the much-touted DES encryption method may not be truly secure from snoops—introduces another topic that simply doesn't get aired in today's anythine-for-a-buck atmosphere.

HEALTHY SKEPTICISM Unfortunately, the healthy skepticism Nelson brings to most shibboleths does not extend to his own. Every time Nelson refers to one of his own personal inventions, pride, egotism, and arrogance end up utterly disabling his otherwise well-tuned manure detector.

When it comes to hypertext, his personal religion, Nolson's otherwise highly charged prose turns to sludge. As he tries to explain his Xanadu project—the Grand Unified Theory of Hypertext, 27 years in the making, replete with "xanalogical storage" and "links" and he "parallel textface"—your eyes begin to fog. Or maybe I've got glaucoma: savyy Autodesk just poured a pile of its cash into Nelson's Xanadu scheme.

As with many visionaries, Nelson is better at principles and proposals than at implementations. The book's "user interface" is Exhibit A. Since each half begins with page 1 and is numbered consecutively thereafter, Nelson came up with a special cross-referencing scheme, preceding all page references to the Dream Machine's side with the letters DM and all references to the Computer Lib side with nothing at all. Since the book virtually demands browsing rather than straight-through reading, this is precisely the kind of counterintuitive "you-have-to-think-twice" solution Nelson inveighs against so often throughout the book. With unerring regularity, you end up in the wrong place, utter a volley of oaths, and have to flip the book over to try again.

But the book's worst flaw is its lack of both an index and a table of contents. From a fellow who touts his Xanadu system as a "data management system for handling extremely complex data in huge files," these omissions poke a big hole in what's otherwise a veritable Pleasure Dome. 22



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PC MAGAZINE . SEPTEMBER 13, 1988



MYSTIQUE

C IS HOT THESE DAYS. ASK PROresional softwar developers which language they use for PC applications and the answer will amont invariably be: "C with some assembly language subroutines." Ask PC Magazine's programming readers which language they are most interested in, and C leads by far—though it is not yet he language that most are using. And when PC Magcitate comments of the programtion of the program of the programmore than are available for Paccal, BA-SIC COBOL, or FORTRAN.

That's an impressive achievement for

a language that made its way out of Bell Labs a mere 10 years ago.

Laws a mere to years ago.

C's popularity has not yet peaked; as
we move into the 1990s, it's likely to become even more pervasive. Since C is
suited for writing applications that run
under the OS/2 Presentation Manager, it
appears that C will be, at least initially,
the most common language used for the
next generation of PC software.

BEGINNINGS C was invented by Dennis Ritchie at AT&T Bell Laboratories in the early 1970s. Why is it called C? The answer is simple: it was derived from an earlier language called B. C was used internally at Bell Labs at first and only gradually made is well the rest of the world. One important steps was the publication, in 1978, of The C Programming Language, a 228-page uttorial, language obscription, and reference manual countbowed methods and reference manual countbowed programments as K&R, this book was the authority on C for many spears, even as the language evolved and changed. K&R has only recently been inbus "The Classics C Tuner, Revised"), bus "The Classics C Tuner, Revised").

Some programming languages—most notably Pascal and APL—were not designed specifically for programming, strange as that may seem. Niklaus Wirth, for example, developed Pascal in 1968 for teaching his students about proper program structure. The first Pascal compiler was written a coule of years later.

C, on the other hand, was created for real-life programming. The language has a block structure much like that of earlier languages such as Algol, Pascal, and PUI. Yet programs written in C are often more concise and more efficient than those in other languages. C was designed to be efficiently compiled by relatively simple compilers. This fact, along with C's flexibility, allows C to be an adequate substitute for assembly language.

One of C's first big jobs was the Unix operating systems. Most operating systems (DOS for example) are written in assembly language and are therefore closely tied to the machine for which the operating system was designed. About 95 percent of Unix is written in C, as are most Unix utilities and applications. This has allowed versions of Unix to be adapted to many different computers.

LOW LEVEL, HIGH LEVEL Programming languages are often categorized as "low level" or "high level." Assembly language, for instance, is considered low level because it translates directly into the machine code that the computer's processor reads and interprets.

All other languages are high-level languages; a compiler (or interpreter) must read the program and translate it into machine code. One statement in a high-level language often translates into several assembly language statements.

But some high-level languages are higher than other—it depends on the extent to which the programmer is insultated from the workings of the computer. C is often categorized as one of the lowest of the high-level anguages; some programmers have even termed it a high-level as-embly language. C seems to straddle the low-levelhigh-level dichotromy and bold-ly proclaim." If am both, "

ryprocum: 1 am oon.

Programming languages must achieve increasingly higher levels to serve as the basis for increasingly sophisticated applications. Five or 10 years ago, virtually all applications for small computers were

Created for real-life programming, C was designed to be efficiently compiled by relatively simple compilers.

written in assembly language, so the move to a high-level language like C is a natural cone. But why the lowest of the high-level languages? It finds, partly, it's because programment with a background in assembly language are very demanding of high-level languages. Most high-level languages. Most high-level languages have inherent restrictions upon the programment of the programment and the programment ends up spending an inclusion amount of time searching for ways around the language's limitations.

In contrast, C is liberating. The flexibility of the language makes it easy to duplicate many assembly language functions, while programs can be written in less time in more understandable and maintainably language in a relatively straightforward manner without to many supprises. Because is capable of relatively low-level operations, C programs can achieve levels of speed and efficiency comparable to assembly language programs.

THE FUNDAMENTALS In understanding C, it's helpful to know what Denins Ritchie had in mind when he designed the language. In the preface to the first edition of The C Programming Language, Kerniphan and Ritchie wrote:

cerughan and Nitchie wrote:

Cis a general-purpose programming language which features economy of expression, modern control flow and data structures, and a rich set of operators. Cis not a "very high-level" language, nor a "big" one, and is not specialized to any particular area of application. But its absence of restrictions and its generality make it more convenient and effective for many tasks than supposedly tive for many tasks than supposedly

more powerful languages.

This doesn't quite sound like the wonderful language that C programmers rave about, but let's examine some of the lan-

guage's characteristics. At first encounter, C seems like a rather conventional block-structured language. It has a collection of control flow statements, for instance, that are similar to those in other languages, such as Pascal: The if and else statements test a condition to determine whether a statement or a group of statements should be executed. The switch and case statements are a fancier version of the if statement, where the decision making is based on the comparison of an expression with a collection of constants. The for, while, and do statements are all forms of loops. They execute a statement or block of statements repeatedly until a condition is met. C also has a goto statement, but it's not needed for most purposes.

A C program is built out of functions, with one function (always called main) as the entry point to the program. Functions can call other functions (or themselves), passing arguments to the functions and getting values back.

Most of C's data types are also fairly standard. These data types include char (characters and character strings), 1nt (integers), short (short integers), 1 ong (long integers), 1 ond (single-precision floating point), 2 supports arrays (a collection of data of the same type) and structures (a collection of data of the same type) and structures (a collection of data of the same type) and

A GUIDE TO C PROGRAMMING RESOURCES

So you've decided to take up C programming? You may find that choosing a C compiler is a lot easier than starting your C library.

Responding to the increasing popu-larity of C, publishers engaged in cutthroat competition for shelf space have released a veritable tidal wave of books. Using the time-honored (and paraphrased) rule of thumb that 90 percent of everything is dreck, you might guess that most of these books have no obvious reason to exist other than market positioning. You'd be right. But here are some books in that other 10 percent that won't let you down.

In the area of tutorials for C newcomers, the book of choice is Turbo C Programming for the IBM (\$22.95; ISBN 0-672-2261-6) or its clone, Microsoft C Programming for the IBM, by Robert Lafore (\$24.95; Howard K. Sams & Co., Indianapolis, Ind., © 1987; ISBN 0-672-22614-6). I admire this book for its clear writing, practical approach, and well-designed example programs.

If you prefer an interactive introduction to C, check out The C Workshop, by Charles Pine (available for \$69.95 plus shipping from Wordcraft, 3827 Penniman Ave., Oakland, CA 94619, © 1987; ISBN 0-917419-12-X). This combination book and software package includes an integrated editor/compiler for small C programs with on-line help.

Once you've worked through one of these tutorials, you'll want to explore some more-advanced C programming techniques:

Proficient C, by Augie Hansen (\$22.95; Microsoft Press, Redmond, Wash., © 1987; ISBN 1-55615-007-5), teaches good C programming practices with particular emphasis on the design of user interfaces. It includes source code for many useful utility programs.

Turbo C'Memory-Resident Utilities. Screen I/O, and Programming Techniques, by Al Stevens (\$24.95; Management Info Source Press, Portland, Oreg., © 1987; ISBN 0-943518-35-0) stresses management of the display, data entry screens, and TSR (terminate-and-stayresident) program tricks of the trade.

System Software Tools, by Ted Biggerstaff (\$31 (hardcover), \$19.95 (paperback); Prentice-Hall, Englewood Cliffs, N.J., © 1986, ISBN 0-13-881764-2), is an advanced, wide-ranging book that deals with such topics as process management, multitasking, and serial communications

Two other books that definitely belong on your C shelf are:

Debugging C, by Robert Ward (\$19.95; Oue Corp., Indianapolis, Ind., © 1986; ISBN 0-88022-261-1), is a unique and valuable book on a sadly neglected subject. It explains how to find, fix, and prevent the most common C programming bugs, and at the same time teaches how C programs and their run-

time libraries really work. Programming Windows, by PC Magazine columnist Charles Petzold (\$34.95 (hardcover), \$24.95 (paperback); Microsoft Press, Redmond, Wash., © 1988; ISBN 0-914845-91-8), is one of the most elegant programming books in print. Whether you are specifically interested in Windows or not, you can learn a lot from this book about writing maintainable, well-documented C programs that do exactly what they are supposed to do-no more, no less. Along the way, you'll pick up a lot of interesting new concepts that apply to any multitasking, message-driven environment with pointing devices and a graphics interface. And our list of C resources wouldn't be complete without the following holy The C Programming Language, sec-

ond edition, by Brian W. Kernighan and Dennis M. Ritchie (Prentice-Hall, Englewood Cliffs, N.J., © 1988; \$40 (cloth), ISBN 0-13-110370-9; \$28 (paperback), ISBN 0-13-110362-8), is the definitive book on C programming. It's dense with meaning; not too useful if you're just learning C, but a great settler of arguments because Dennis Ritchie designed the C language. Affectionately known as K&R to Unix/C hacker types. Bell System Technical Journal published two special issues (Vol. 57, No. 6,

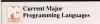
Part 2. July-August 1978, and Vol. 63. No. 8, Part 2, October 1984) that were devoted to articles by C and Unix founders, gurus, and mystics. Many interesting tidbits of history can be found here! Owing to popular demand, these two back issues have remained in print and are readily available at any good technical bookstore. C compiler vendors have rallied to

"ANSI C Compatibility" as a new marketing weapon-remarkable since the ANSI C standard has not yet been approved (as of this writing). But you can get the Draft Proposed American National Standard for Programming Language C to decide for yourself. It is available for \$65 from Global Engineering Documents, P. O. Box 19539, Irvine, CA 92714; (714) 261-1455. -Ray Duncan

Ray Duncan is a contributing editor of PC Magazine.

Kernighan and Ritchie assert that C is not a big language. C has only 32 reserved keywords, and I've already mentioned alover 200 reserved keywords. Although C is small, it has, as Ker-

est version of Microsoft QuickBASIC has | of operators"-some 45 of them. These include the more-normal operators for arithmetic calculations (+, -, *, and /) and most half of them. In comparison, the lat- | nighan and Ritchie describe it, a "rich set | comparisons (< and >), and also a collec-



This overview dentifies some of the major programming languages by primary application and publication date. Not every language is represented here, but those that are have either historical significance or an important application in the PC environment. For example, PCR-TRAN is a high-level language used to create many soenflict and engineering applications on PCE. PGRT has many dedicated

1950

COBOL (1959) COmmon Business-Onented

Common Business Oriented Language Developed by Be Department of Defense. COBDL was fine-funded by Cast. Grace Hopper of the U.S. Nasy COBDL so one of the roots wide in any COBDL so one of the roots wide in any COBDL so one of the roots wide in any COBDL's syntax is primarily known for business applications. Highly structured but wordy. COBDL's syntax is Engists-like and intrinsically self-documenting.

1960

Report Program Generator. Created by IBM, RPG is generally classified as a nonprocedural tanguage for producing business reports.

BASIC (1964

Beginner's All purpose Symbolic Instruction Code Developed at Dartmuch College by T.E. Kurtz and J.G. Kemeny, BASIC was created to leach students programming. Peasures of BASIC include array and stimp ampoilation. It is widely used on microcomputers and miniocomputers of educational and business applications. BASIC in easy to understand and learn and is appropriate for solving small problems.

PONTRAN (1959)

FORmula TRANslator. Developed by an IBM feam headed by John Backus. FORTRAN was the first high-level language. Known as a scientific language because of it lacility for number crunching. FORTRAN also has good arrayhanding leatures. ALGOnthmic Language ALGOL

S8 was designed by a committee of members of the Association for Computing Machinery and European computer industry representatives. ALGOL 60 and ALGOL 68 were later versions. Useful for mathematical problem-solving. ALGOL was the first block-oriented language.

APL (1962)

A Programming Language Developed by Kenneth Iverson and used marrily in scentific applications, APL is known for its scope, compactness, and facility with arrays APL has a highly specialized character set, which may be mapped to the keyboard.

LISP (1960)

LISt Processing. Created by John McCarthy, LISP uses the data type list as its basic element. Many artificial-intelligence applications are written in LISP. SNOBOL 4 (1963)

String-Onented symBOlic Language Developed by David Farber, Raiph Griswold, and Ivan Polonsky of Bell Labs, the current version of SNOBOL is still in use for text applications, including databases and editors.

PC MAGAZINE . SEPTEMBER 13, 1988

followers who enjoy its extensibility, which allows a programmer to add data elements to its "dictionary," SNOBOL's string-handling ability made it the language of choice for creating ocean types of databases and compilers. No one can get a degree in computer science without exposure to CODOL, and its wordy but efficient structures. And

MODULA-2 was brought to you by Niklaus Wirth, the creator of Pascal. Classifying a language according to its generally accepted purpose does not preclude other applications. For example, there are databases written in FORTRAN, business applications in C, and many IBM System 34 and 36 applications in RPG.—Pamele J. Millend

1970

1980

-10

The name is not an ecronym, eithough many think of it as Programming Language 1. IBM created PL/1 to replace COBOL end FORTRAN, but this expectation has not been fulfilled

A 2 db grid matuficilità

Pascal (1971)

Nemed after the 17th century
methemetroen Blaise Pescal.

Niklaus Wirth invented Pescal to teach his students the art of
programming. Pescal produces
structured programs, simple to
follow and melitaria, end is
extensively used on microcompu-

Ada (1979)

Nemed efter Ada Auguste, the Countess of Loveleon, assistent to Cheries Babbage. Ade, based on Pascal, was created by a group of programmers headed by Jean Inchiah under contract for the U.S. Oppariment of Deferees. It is used throughout the federal government for explications beyond its original purpose—weepons system.

MODULA-2 (1979) MODUlar LAnguage 2. MODULA

Carlos Ca

2 was written by Pascal designer Niklaus Wirth in response to the need for an enhanced Pascal. It is e multiprocessing languege with coroulines that mey be executed simultaneously.

tracking.

C (1975)
The successor of a language named B. Dennis Ritchia created C for the Unix operating system. C is used for systems and general applications end is known for compactness, memory conservation, and power.

C++ (1983)

Designed and implemented by Bjarn Stroustrup at Bell Labs, this is en object-onemed superset end extension of C. Rumor has it thet Bell Labs calls C++ "C" and C "Old C"

PROLOG (1970)

PROgramming LOSic. Written by Alein Colimerace at the University of Merselles, France, PROLOG is used length for artificialintelligence applications. It is a logic-oriented language, arriving et e problem's solution by tresson ing' its way to the ensiwer. It is declarative rether than procedural, solving problems based on rules that the progremmer has input.

FORTH (1974)

Should have been called "Fourth" (as in fourth generation), but the computer used by its developer, astronomer Cheries Moore, accepted only fire-character names. An object-centred language originally created to control telecopers, FORTH's law yingredient is the word. Words (like atoms) may be strung together and may have pointers to the locations of other words. This extensibility of FORTH is a key to its over-growing popularity.

Smalltalk 80 (1980)

Developed at Xerox's Palo Alto Research Center and implemented with the help of Alan Key Smaltalk is an object-onemed language used for Xerox's original graphical windows system. Actor, the language for Mercoot! Windows is derived from Smaltalk. tion of operators that can test or manipulate individual bits of numbers. It's only when you encounter operators such as & (called address of) and * (pointer indirection) that C does not appear normal. More on these shortly.

CONCISE SOURCE CODE Kernighan and Ritchie make note also of C's "economy of expression." In other words, C programmers can spend less time at their keyboards.

In some cases, C's brevity involves using symbols where other languages use words. In Pascal, a programmer defines the beginning and end of a block of statements using the words BEGIN and END. The C programmer uses { and }. In other cases, the conciseness has deeper implications. Let's look at an example.

Like those of most programming languages, C arithmetical operations are based on an algebraic model. The following C statements, for example, are easily comprehensible to nonprogrammers as well as programmers:

X, Y, and Z are variables. The first two statements set X equal to 2 and Y equal to 3. The third statement sets the variable Z equal to the sum of X and Y, or 5.

Suppose you want to increment the variable X by I. In C, as in most other programming languages, you can do it with a statement like this:

$$X = X + 1;$$

But why must the variable X appear twice in this statement? All you want to do is add 1 to X. If the variable name were not simply X but a long word, this statement would involve a lot of unnecessary typing.

C has an alternative notation for operations of this sort:

Programmers know that the job of incrementing or decrementing a variable by 1 is very common in programs. Most languages, however, do not have special operators for this job. C does. You can also add 1 to X with the statement:

The ++ is the C increment operator. Similarly, -- is a decrement operator.

This increment operator fits easily into

a more complex statement:

This statement subtracts X from Y, multiplies the result by 2, and stores it in Z. X is then incremented by I. If you want X incremented by I before it is used in the calculation, you can put the ++ in front of the variable:

$$z = 2 * (Y - ++X);$$

This use of the += and ++ operators is not just a form of shorthand for the programmer. It also belps the C compiler because the simplified statements suggest a greater number of optimal assembly language instructions that the compiler could use to increment the variable X. For example, a not-very-intelligent compiler would translate the first version

$$x = x + 1;$$

into three 8086 assembly language statements:

(AX is a register in the microprocessor. These three statements cause the contents of X to be loaded from memory into the AX register, 1 to be added to the contents of the AX register, and then the result stored back into memory.

The second version

Add [X], 1

But the third version

x++;

is most efficient of all:

Inc [X]

Most modern C compilers for the PC implement some degree of code optimization. They'll usually generate the same muchine code (left Inc instruction) for all three versions of the C code shown above. Although it's probably no longer necessary to use the ++ operator to get the most efficient code from a C compiler, there are other cases in which the proper us of operators results in more-efficient prooperators results in more-efficient pro-

ASSEMBLY LANGUAGE PROPERTIES In designing C, Dennis Ritchie was well aware that most computer processors have

grams.

machine-language instructions that increment or decrement a variable by I and that these instructions are more efficient than instructions that add or subtract I. Yet, C. is one of the few high-level languages that have increment and decrement operators. This is why C is sometimes called a "highlevel assembly language"—it generalizes certain properties found in all assembly languages.

Another example: Most computer processors have internal registers, such as the AX register discussed earlier. Manipulation of numbers stored in these internal registers is often much faster than manipulation of numbers stored in memory.

C allows the programmer to specify which variables should be stored in the processor's internal registers. These are often variables that are used a lot in a particular section of a program, and the programmer can assist the compiler by identifying them.

Many assembly languages have lots of instructions to test, set, and shift the individual bits of variables. In contrast, many high-level languages do not have bit operators. C does. But the concept that most clearly reveals C to be a language for real computers with real hardware is the C "pointer."



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C AND POINTERS In the C examples shown above, I used variable names of X, Y, and Z. In most high-level languages, variables are rather abstract entities. They are sometimes portrayed in programming instruction books as little boxes or cups that hold the current value of the variable.

C, however, tells you a little more about what variables actually are. The cents of a variables actually are. The cents of a variable such as X, Y, and Z are stored in memory. Each variable is associated with a particular memory location, which has a numeric address. Although the actual numeric value of an address may be meaningless to a program, a C program can access a variable by referring to the address itself. The address itself In dedress itself. The

er" to the variable. In one sense, this is not a profound or revolutionary concept. Of course variables are stored in memory. Of course the contents of a variable can be accessed using an address. That's how a computer works! But this concept—if it appears at all in other high—level languages—is hardly essential. In C, however, pointers are fundamental to the language.

Along with data types that mark a variable as a character, an integer, or a floating-point number. C also supports a pointer data type. That is, you can have a variable that a pointer to a variable of a particular data type. You can perform arithmetic on these pointers, and this arithmetic takes into acount the type of variable to which the pointer is pointing.

C has two basic operators for working with pointers. The first is the ampersand (&), which obtains the address of a variable. In this example, the variable named Ptr is a pointer:

The asterisk (*) is called the "indirection" operator. This is used to access the contents of the memory location to which the pointer points:

These two statements, taken together, are equivalent to

THE CLASSIC C TUTOR, REVISED

In 1978, the first edition of Brian W. Kernighan and Dennis M. Richie's book, The C Programming Language, was published and quickly because and classic. Known among its admirers simply as K&R, this is the book that taught early C programmers and settled all agreements about the language, Richie, after all, was C's investor. And many C compilers, until necently, were advertised as supporting "full K&R C."

The first edition of The C Programmy Language contained a brief uturnial, a detailed description of the language, a discussion of the standard library controls, and a reference manual that formally described C syntax. It was written in a relaxed, laid-back style with plenty of real programming examples that clearly displayed the elegant power of C. Lise Citself, K&R was concise and economical, packing a lot of information into 228 pueces.

K&R, however, has slowly aged since its publication. In particular, the book describes only the most basic library functions. The standard library has grown over the years, and most modem C implementations support many more functions than Kernighan and Ritchie covered.

Ten years have now elapsed since its first publication, and the classic has recently been revised. The second edition of The C Programming Language now includes the changes made to the C Inaguage as a result of the ANSI standardization effort. Still brief and concise (only 44 more pages longer than the first

edition), K&R 2 is must reading for ev-

ery C programmer. Much of K&R 2 is the same as the first edition; aside from its expanded il-brary functions. C line changed fittle or brary functions. C line changed fittle or brary functions. C line and for the companion of the function. Kernighan and Ritch's endocement of the new why fe function officialization (see why fe function officialization (see a possible of the companion of the comp

K&R 1 contained only one appendix: the C Reference Manual. K&R 2 updates this appendix to include the new ANSI changes, with brief notes pointing out the differences. A second appendix in K&R 2 now describes the ANSI standard library.

brary.

If you buy only one C programming book, it should be K&R 2. Prentice-Hall promises to keep K&R 1 in print until compilers supporting the new ANSI C standard become widely available.

standard become widely available.

—Charles Petzold

List Price: The C Programming Language, second edition, by Brian W. Kernighan and Dennis M. Ritchie, \$40 (cloth), \$28 (paperback). ISBN 0-13-110370-9 (cloth), 0-13-110362-8 (paperback). Prentice-Hall Inc., Englewood Cliffs, New Jersey.

because in either case the value of 2 is stored in a memory location pointed to by the address of X.

Along with the "address of" and "indirection" operators, C has other essential support of pointers. For instance, the C language guarantees that certain collections of data are organized in a predictable manner. In particular, the elements of an array are stored sequentially in memory, thus allowing a program to access these el-

ements efficiently using a pointer.

Let's look at an example that shows how pointers can improve the efficiency of certain common tasks. In the examples following, the variable Array is a two-dimensional array of 10,000 integers (100 rows by 100 columns). You want to set each element of this array to a value equal to the sum of the row and column index.

In C, you might initialize the array using the following code, similar (except for

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■ C LANGUAGE



C Elegance, C Power

C is well known for its ability to do tasks that are difficult or awkward in other programming languages. To illustrate this, here are three programs, one for either DOS or OS/2, one for DOS, and a third for OS/2.

These three programs can be compiled using Microsoft C, Version 5.1. Depending on library support and OS/2 support, they may be used as is or adapted for use with another compiler.

STRIPEND

The STRIPEND program removes blanks or tab characters from the ends of lines in an ASCII text file. The program uses redirection of standard input and output:

STRIPEND <infile >outfile

Don't use the same filename for both! C is very well suited for jobs involving redirection of standard input and output because redirection originated in Unix, for which C was designed.

The gets function reads one line from standard input and stores it in the array called 1 ine. (The program assumes that no line in the input file is longer than 1,000 characters.) The STLTEV function reverse the characters of the string in memory and returns a pointer to the beginning of the string. Because the string has been reversed, the pointer actually points to the last character from the original string.

The StTSpf function finds the first character in the string that is neither a space nor a bid findstated by the STD parameter \(^1\) Li, underturns an offset from the beginning of the string. That value is added to 11 no. which is a pointer that points to the beginning of the string. The result is a pointer that points to the beginning of the string. The result is a pointer that points to that the string that is not a space or tab. First scharacter in the string that is not a space or tab. First scharacter in the string that is not a space or tab. First scharacter in the string that is not a space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not a space or tab. First scharacter in the string that is not space of tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that is not space or tab. First scharacter in the string that scharacter is not space or tab. First scharacter in the string that scharacter is not space or tab. First scharacter in the string that scharacter is not space or tab. First scharacter in the scharacter is not space or tab. First scharacter in the scharacter is not scharacter in the scharacter in the scharacter is not scharacter in the scharacter is not scharacter in the scharacter is not scharacter in the scharacter in the scharacter in the scharacter is not scharacter in the scharacter in the scharacter is not scharacter in the scharacter in the scha

/TRIFESO.C -- Strips trailing blanks and tabs from ASCIT text files.

Syntax: STRIPESO <infile >outfile ...

#include <etdio.h>
#include <etdio.h>

int main (wold)

static char line(1898);

while (NULL != gets {line)}
puts {strrey (line + streps (strrey (line), " \t"))) :

COMPILING THE PROGRAMS

You can compile these programs if you have Microsoft C, Version 5.1, installed. (Compiling these programs using other C compilers may require changes in the programs and in the way they are compiled.)

If you're a DOS user, you have probably installed C 5.1 for DOS only. You can compile NUMLOCK or STRIPEND for DOS by the command

CL progname.C

where "progname" is either NUMLOCK or STRIPEND. If you installed C 5.1 for OS/2 only, you can compile CDIR and STRIPEND for OS/2 using the same command:

CL progname.C

If you installed C 5.1 for both OS/2 and DOS, use the command

CL -Lr progname.C to create DOS versions of NUMLOCK or STRIPEND, and the command

CL -Lp progname.C

to create OS/2 versions of CDIR or STRIPEND.

When you compile either CDIR or STRIPEND for OS/2, you can optionally create a "dual-mode" executable program that runs under either OS/2 or DOS. Use

CL -Fb progname.C

if C 5.1 was installed for OS/2 only, or CL -Lp -Fb progname.C if C 5.1 was installed for both OS/2 and

DOS -Charles Petrold

NUMLOCK

The DOS program, NUMLOCK, toggles the state of the NumLock key. NUMLOCK illustrates how C can convert a number to a pointer and then use the pointer to manipulate items in memory.

Under DOS, the current states of the shift keys are stored in the BIOS data area at hexadecimal address 40:0017. NUMLOCK uses this address (in the aumeric form 34:00017) and "casts" is into a pointer, the asterisk references the byte at that memory location. The ^= operator performs an exclusive OR of the byte with 0x20 (32 in decimal) to toggle the NumLock bit.

NUMLOCK then compares the shift key byte with 0x.20. The program returns a I if NumLock is on and a 0 if NumLock is off. This value can be tested using the ERRORLEVEL statement in a bauch file. For example, if you wanted to turn off the NumLock key in a batch file, you could use the batch file statements

: TURNOFF NUMLOCK

IF ERRORLEVEL 1 GOTO TURNOFF

CDIR

The OS/2 program, CDIR, mimics the normal DIR command. The formatting of the output is done by the powerful Cprintf function. CDIR has some limitations. If you supply a file specification parameter, such as

CDIR C:\TEXT*.DOC

it must be a full file specification. You cannot simply specify the directory, like this:

CDIR C:\TEXT

If you supply no parameter, CDIR lists files in the current directory. CDIR does not list subdirectories. The file times and dates are hardcoded to a U.S. format. As a bonus, however, CDIR lists system files and hidden files and

indicates file attributes using the letters A (archive), S (system), H (hidden), and R (read-only). The DosFindFirst and DosFindNext functions are part of OS/2—they retrieve information on files that match a given file specification. OS/2 stores this information in a structure of type FILEFINDBUF, which is defined in an OS/2 header file.

The first parameter to print f is a formating string. For example, the the relation of the first parameter is 4.8 specify that a left-justified string is to be printed in a field width of eight characters. Wid 2d specify a field two characters wide to display a decimal number. If the number is less than ten, it is padded with a leading zero. (This is useful for displaying the file date, for example.)

Most of the structure fields are passed to printf directly. The most difficult job for CDIR is separating the base name and extension of the filename. This job makes use of the C StrUck function, which breaks a string into "lokens" separated by delimiters. In the case of a filename, the delimiter is the period between the base name and extension.—Charles Petzola

```
/* MREACE.C — Topgies Sendock bey in DOS.

SENDOCK CO. Topgies Sendock bey in DOS.

Syntax SENDOCK

for main (resid)

From 1 (* charf far *) $2459917 ~ (*\250 ) 1 8 3 7 1 8 3
```

```
COULT - Streetery file list poth stributes for oid;

spates 200 [filespee]

**Filespee coult filespee]

**Filespee coult filespee]

**Filespee coult filespee]

**Filespee coult filespee;

**Filespee
```

} while (|DosFindWest (handle, &ffb, sizeof ffb, &search)) ;

return 1 :

return # :

obvious syntactical differences) to Pascal or BASIC code:

The two for statements are loops. The first for statement initializes the variable it to 0, executes the statement that follows (the next for statement), increments (using i++), and continues if i is still less than 100. The second for loop does the same for j. The third statement uses i and j to index the array and store in that element the sum of i and j.

For the beginner, C can be treacherous territory. Part of C's efficiency stems from the assumption that the programmer knows what he or she is doine.

The i and j indexes to the array designate approaches a particular element of the array and hence a particular memory location relative to the beginning of the array. The Complier must generate machine code to calculate that address from it and it. This within the comparison with most order transchine code inductions with most order transchine code instructions) takes a long time to execute. So this little job—innocent as it may appear—requires 10,000 multiplications.

But there's a better way. C guarantees that the elements of this array are stored sequentially in memory beginning with Array[0][0], Array[0][1], Array[0][2], and so forth. The variable mane Array used by itself in a C program is the address of the first element of the array. If you fill up the array in the order in which the elements are stored, it is not necessary to calculate the address of each ar-

ray element. The address of the element need simply be incremented:

The last line stores the sum of i and j in the memory location, or address, pointed to by Ptr (which starts out as the address of Array[0][0]) and then increments Ptr to the next element. There is no longer a need to calculate the address of each element. The multiplications are good! This version will require less code and will run faster.

Can a smart optimizing compiler generate efficient code when a programmer uses normal array indexing rather than pointers? In some cases, yes, A smart compiler can determine that it need not perform a new address calculation 10,000 times, that it can do something a little better. But until compilers become smarter than programmers, the programmer can always help the compiler by steering it in the right direction.

LIKE PUZZLE PIECES The more experience a programmer has with C, the more C reveals itself to be a very well designed language. Everything fits together nicely: basic elements of the language can be pieced together into very compact and elegant code.

A string is an array of characters that is terminated by a zero character, (0. This zero, or null, character can also serve as a test in the middle of a for statement to determine whether the loop should continue. For example, if the variable CharStr is a character string, you can find the length of the string with this code:

After this statement executes, the variable i is the length of the string.

Another example: If the pointer Ptr1 points to one zero-terminated character string and you wish to copy the string to another location pointed to by Ptr2, you can do so with a while statement:

PORTABILITY AND LIBRARIES Of course, you don't have to write your own code to find the length of a string or to copy a string from one place to another: a couple of library functions will do that for you. Functions like these are available from manufacturers of C compilers in libraries

you can link to your C program.
The relationship between the C language and C library functions is strange. You may have heard or read that C is rowned for its high degree of "portability." In other words, a C program written for one system can often be recompiled and run on another system without any chances to the source code.

But there's a catch to this portability. Strictly speaking, the library functions are not part of the C language. While the language itself may have a high degree of standardization among systems and compilers, the library functions are far less standardized. Yet without these functions, you don't even have any means of input or

output! C also achieves portability by deliberately leaving some aspects of the language undefined, or implementation dependent. For example, how many bits are in a C integer? It depends on the machine and the compiler. A program can be portable only if it makes no real assumption about the size of an integer.

LIVING DANCEROUSLY For the beginning C programmer, C can be treacher-ous territory. Part of C's efficiency stems from the assumption that the programmer knows what he or she is doing. For example, C does no runtime checking of army indexes. If you define an army of 10 integers, C will let you index that army far beyond 10. What will you be accessing beyond the end of the army? If could be

anything. Even if a "safe" C compiler were to implement runtime array bounds checking, it could not check pointers. By their very nature, pointers can point to nearly anything—and often do. The wild pointer—a pointer that is not set with a valid address—is a common C bug.

C is not a strongly typed language like Pascal. A variable of any data type can be translated into a variable of another data type. Although this contributes to C's flex-

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Popular Programs and Their Languages

ver wonder what language your favorite program is written in? Here's a sampling of some of the more popular PC programs. If you follow many of these packages through revisions, you'll see an increase in the preference for C

Program	Manutacturer	Language	
Crossialk XVI	Digital Communications Associates Inc.	Assembler	
dBASE II	Ashton-Tate Corp.	Assembler	
dBASE III Plus	Ashton-Tate Corp.	С	
dBASE IV	Ashton-Tate Corp.	C	
Microsoft Excel	Microsoft Corp.	C	
Microeoft Word (all versions)	Microsoft Corp.	C, Assembler	
1-2-3, Release 2.01	Lotus Development Corp.	Assembler	
PegeMeker	Aldus Corp.	C	
Paradox (all versions)	Borland International Inc.	C	
PC DOS	IBM Corp.	C. Assembler	
PC-Telk (ell versions)	Headlands Communications Corp.	BASIC	
R:base Series 5000	Moronm	FORTRAN	
R:base System V	Micronm	C. FORTRAN, Assembler	
R:base for DOS	Microrim	С	
SideKick	Borland International Inc.	C, Assembler, Pascal	
SideKick Plus	Borland International Inc.	C, Assembler, Pascal	
Surpass	SurpassSoftware Systems Inc.	MODULA-2	
WordPerfect (all versions)	WordPerfect Corp.	Assembler	
WordStar, Vereion 4.0	MicroPro International Corp.	Assembler	
WordStar Protessional, Version 5.0	MicroPro International Corp.	Assembler	
WordSter 2000 Plus, Version 3.0	MicroPro International Corp.	C, Assembler	
XyWrite	XyQuest Inc.	Assembler	

ibility, it often causes very subtle bugs when signed and unsigned data types are mixed in the same expression.

A C compiler won't stop a program from calling a function-even one of the standard library functions-that has an incorrect number of parameters. Again, the assumption is that you're doing it for a purpose. (Most C compilers will, of course, warn you about such behavior.) In short, programming in C is program-

ming without a safety net. It's a thrilling experience until you fall on your face.

C INTO THE FUTURE The original definition of C as described in Kernighan and Ritchie's book formed the basis of all implementations of C. Over the years, however, enhancements to the language were gradually added, mostly in the form of additional library functions. C was in danger of becoming less portable as time went on; already people were speaking of

different "dialects" of C. In 1983 ANSI, the American National Standards Institute, began the process of establishing a standard for C. Five years later, the process is almost complete, and the final ANSI C standard will soon be documented (see the sidebar "Standard C:

"Compiling the Facts on C" In most cases, ANSI C simply formalizes the many changes to the language that

have evolved over the years. It consists of a more precise definition of the language (geared toward programmers of C compilers rather than programmers of C applications) than the one offered in Kernighan and Ritchie's book. ANSI C also sets minimum values for certain implementation-dependent values. (An integer, for example, must be at least 16 bits long.) Many C library functions have also been standardized

In 1983 the American National Standards Institute began to establish a standard for C. Five years later, the process is almost complete.

To an extent, the danger of standardizing a language is that the language will no longer continue to grow. Even now, as C stabilizes, a successor to C called C++ (pronounced "C plus plus" - and yes, that is the C increment operator) is making headway. Developed by Biarne Stroustrup of Bell Labs, C++ is basically a superset of C. Its main advantage over C is a facility to define new data types for use in objectoriented programming. And because the C++ language is a superset of C, it is almost trivial to port existing C code to the new language; enhancements to take advantage of C++ features can then be added incrementally.

Although C++ as a successor to C may be more appropriate for some programming tasks, it certainly is not to be considered a replacement for C. Once strengthened and enhanced by ANSI standardization, the original C language is likely to remain a powerful force in per-The ANSI Draft Grows Up" in the article sonal computer programming.

> Charles Petzold is a contributing editor of PC Magazine.







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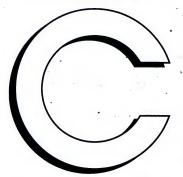
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COMPILING . THE FACTS ON.



PC PROGRAMMERS ARE DEVELoping a crush on C. As Dennis Ritchie, author of C, recently observed, C has rocketed from being a tool for Unix systems programmers to occupying a pre-Evaluating the ferred position in PC software houses.

Three years ago every machine cam traits of the with a free BASIC interpreter (in ROM new generation or on-disk) and an assembler (DEBUG), while C compilers were costly and comof C.compilers. plicated. Today, with full-fledged professional C compilers available for less

than \$100, the power of C is available to every professional and casual programmer. With so many feature-laden C compilers at such attractive prices, how do you choose one? Part of the answer is to have an understanding of how far C compilers have traveled since the PC's first appearance in 1981.

THE C CHRONICLES When the IBM PC first appeared, the undisputed leader in the C compiler market was a CPM-based compiler known as BDS-C. Created by Leor Zolman, BDS (which stood for "Brain-Damaged Software") featured a number of utilities, clean documentation, and a modest mutine library with full source code. But most of all, it featured speed, it was the fastest CPM C compiler, but none, and speed was what we all sought in those days.

As C compilers began to appear for MS-DOS, many of them used BDS as a model, including DeSmet DC88, which, as our benchmark test results show, is still the fastest to compile among the disk-based compilers reviewed here. Other survivors from those early days include C68Plbs, Arec C, and Lattice C, the virtual "bing of the hill" among DOS C commilers for several years.

However, two events stand out as watersheds in the DOS-based C compiler marketplace. The first was the emergence of Microsoft C, Version 3.0, in 1985. In its subsequent incarnations, the Microsoft C compiler redefined the substance of the professional C development system and optimizing code generation. The second event was the appearance of Borland's Turbo C, Version 1.0, in 1987, With its integrated environment, Turbo C picked up where BDS left off-combining speed with an interface that allowed the user to move through each part of the edit-compile-run cycle effortlessly. Today the demand for compilation speed has been extended to include professional tools. optimized code, and an integrated environment.

A MODEL COMPILER What constitutes a high-quality C compiler? Evaluating the C compilers revolved around several key areas. Although the ANSI C standard is not yet official, adherence to the Standard Draft is important (see the sidebar "Standard C: The ANSI Draft Grows Up"). We were particularly concerned with those aspects of the Standard Draft that imparted immediate benefits to programmer productivity and source-code portability, such as function prototypes, the new preprocessor directives, and keywords. We also looked at how effectively each compiler has implemented the ANSI library (see the table "How ANSI Compatible Is Your C Compiler?").

STANDARD C: THE ANSI DRAFT GROWS UP

With the exception of the publication of Kennighan and Ritche 's The C Programming Language, the effort of the third that the publication of the C language. Over the third that the third

HISTORY OF ANSI C ANSI is responsible for establishing and defining technical, industrial, and commercial standards, and it delegates that responsibility to a group of committees and subcommittees in each field. Its X3 commitee is concerned with Information Systems standards, and the X311 subcommittee is responsible specifically for the Clanciuse standard.

X311 has met quarterly since its formation in 1983. It has more than 130 committee members and nearly as many observers, composed of representatives, along with software and even hardware developers. The list of the officers and committee members reads like an industy honor roll, including figures like P. J. Plaugher, Thomas Plum, Lawrence Rosler, and lim Brusse.

When an informal public review of the Standard Draft was held in March 1985, it resulted in the incorporation of over 800 suggestions into the draft. A formal public review period was held for 4 months beginning in November 1986, with another one taking place early this

At the close of the December 1987 meeting, the X3J11 committee had hopes to finalize the standard at the fol-

lowing meeting, in April of this year.
This was not to be.

The slowdown was partly due to the addition of a new keyword at the December meeting. Since compilers have a difficult time making optimization assumptions about a data object, steps had already been taken to allow the programmer to control the optimization of specific data objects. Thus, the volatile keyword had previously been added to the draft, which indicated data that should not be optimized. Now, the committee members wanted a keyword that would indicate just the opposite: a means by which a programmer could say to the compiler, "Make all the assumptions you want about this variable, and ontimize it completely." Thus, the noalias keyword was introduced in November.

Enter Dr. Dennis Ritchie, the author of the C language. After 5 years of staying in the background, having always worked through the committee's AT&T representatives and never having attended a meeting. Dr. Ritchie objected to the way noalias had been formulated and the implications of its use in the library interface. He showed up at the April meeting, in fact, to have it killed. It was. And while some committee members felt that the concept of noalias might be rescuable and that a replacement might be devised, this could not be done before the following review period. Since ANSI rules stipulate that another public review must take place after changes like this have been made, finalization of the standard was postponed until the September meeting at the earliest.

Only about 20 changes (including the dropping of noalias) were made at the April meeting, unlike the average 100-plus changes per meeting in the past. Since another ANSI rule allows the committee to limit the solicitation of public comment to a consideration of changes that are made, the only parts of the stan-

dard still open to public review are the changes made at the last meeting. So the body of the standard will, in all likelihood, now remain unchanged. And as Tom Plum noted, the changes made since last fall are innocuous enough that a C compiler written then would remain relatively unchanged in conforming to today's draft.

The kind of detail the committee has had to cope with is almost unbelievable. especially when you consider the nature of the few changes made to the draft at the April meeting. For instance, the internal construction of functions such as strcmp(), strncmp(), and mencmp() must now use unsigned integer logic to ensure portability. One change concerned the definition of the time structure in TIME.H. which was modified to allow up to 61 seconds per minute, thus allowing for "leap minutes." Another specified that the fflush() function will now take a NULL pointer argument to indicate that all output buffers should be flushed. Remember, these are from a meeting where relatively few changes were made.

GUIDING PRINCIPLES Personally, but sakeptical about the standardization effort until 1 heard P. J. Plaugher recibe the guiding principles behind the standard at a seminar in 1985. Serving as the backbone of the Standard Draft, these principles have had a great deal to do with the committee's ability to standard Draft, the principles have had a great deal to do with the committee's ability to standard Draft, the principles have had a great deal to do with the committee's ability to standard Draft, the principles include these rules:

The principles include these rules:

"Existing code is important, existing a "Existing code is important, existing the principles include these rules."

implementations are not." That is, don't break working code. If a program conformed to K&R but did not exploit the areas of the language where K&R was vague, it should still work under Standard C.

"C code can be portable" or "pro-

vide a fighting chance for portability," meaning that a well-written program could avoid implementation-dependent (and potentially nonportable) aspects of the standard; it would thus be portable to any environment that supports ANSI Standard C.

"C code can be nonportable." Portability is available, but it will not cripple your ability to write efficient code and stay "close to the machine."

■ "Preserve the Spirit of C." C does not need to be fixed—it was never broken! But since K&R left some gray areas in C, a number of implementations had extended the language or taken liberties of their own. This occurrence inspired a set of additional guidelines:

■ Trust the programmer.
 ■ Don't prevent the programmer from

doing what needs to be done.

Keep the language small and simple.

Provide only one way to do an opera-

tion.

Make it fast, even if it is not guaranteed to be portable: many operations are defined in terms of how the target machine's hardware does it, rather than by a general abstract rule.

Further guidelines recognized that all compilers would be forced to make some changes, warned against making unnecessary changes, and allowed the development of system-dependent code. There is one more crucial guideline: "A standard is a treaty between implementor and programmer."

The implementor has greater opportunities to optimize generated code because the programmer can specifically identify what he is trying to accomplish in his code. In addition, the portability of the source code is ensured for the programmer, assuming he adheres to those portions of the standard that are not implementation-dependent. Finally, programs will become more reliable because will become more reliable because the greater type-checking provided by the standard.

While it would be impossible to discuss the contents of the entire Standard Draft here, a few of the more obvious facilities and features are certainly worth noting. A few archaic keywords were dropped and a number of new ones added, mostly for specifying function and data types and for clarifying optimization intentions (as in the vol.at.lle keyword mentioned previously).

Function prototyping was added, first to help enforce type checking on both the types of the arguments passed to a function, and also to check the assignment control of the arguments passed to a function of the control of the contr

status of the ANSI C Standard Draft, contact

X3 Secretariat/CBEMA 311 First St. NW, #500 Washington, DC 20001 (202) 737-8888

The draft document is long, Instead, you might order a copy of Thomas Plum's book Notes on the Draft C Standard (Plum Hall Inc., 1987). I'm indebted to Tom for simplifying and clarifying many of the details and concepts that occur in the draft document itself. Writing and developing an ANSI

standard for C has been a gargantuan task, and the committee should be applauded for its efforts. With a little luck, by the time you read this the announcement of a standard will be close at hand. While C has evolved considerably in the 10 years since K&R, Standard C will ensure that C remains "powerful, simple, and elegant." — Richard Hale Shaw



While the ANSI standard is not yet official (see the sidebar "Standard C: The ANSI Draft Grows Up"), it is nearly complete and in its final form. The accompanying table evaluates the ANSI compatibility of the C compilers reviewed in this issue. While it would be impossible to evaluate each compiler against the entire standard, the more-obvious facilities and devices have been isolated These should be supported by most implementations that claim ANSI compati-

How to Use the Table Contained in the table are some of the new ANSI keywords, aspects of function prototyping, and preprocessor and pointer syntax changes. (ANSI features that were common to all C compilers are noted in the text rather than in the table.) Fifteen ANSI-required header files are listed, including the extent to which the appropriate function prototypes and macros contained in them were found. Finally, a number of miscellaneous items have been included that would force changes in some compilers, particularly those that claim compatibility with Kernighan and Ritchie. Use this table to judge for yourself the extent to which your compiler is compatible with the (nearly complete) ANSI C draft standard.

New Keywords

The keywords const, enum, signed, unsigned, void, and volatile are an essential part of the standard. All the compilers have implemented enum and unsigned. Note that void can apply to nonexistent function arguments, functions that don't return a value, and generic pointers (that is, pointers that don't point to any particular type of object). Some compilers may have reserved a keyword without actually implementing it-a common practice with

ANSI C Compatibility: Summary of Features listed in ascending price order)

NEW KEYWORDS	\$19.95	\$75.00	S99 00
const	Reserved by compiler	Not available	Reserved by compler
signed	Implemented	Implemented	Reserved by compiler
woid	Implemented	Not available	Implemented
volatile	Reserved by compiler	Not evalable	Reserved by compiler
PREPROCESSOR CHANGES	Longer		compiler
Syntacticel changes			
Sarror	0	0	•
		0	•
1		0	•
Spragma	•	0	
New escape sequences			
\a	•	0	•
/*	•		•
Predefined macro names			
DATE	•	0	•
STDC	•	0	•
TIME	•		•
FILE	•	0	•
LINE	•		•
Adjacent string literals concetsnated include files	•	•	•
#include "haader 1"	•	•	•
#include <haader2></haader2>	•	•	•

processor Changes ANSI compatibility requires changes to the preprocessor of most C compilers. Full compatibility requires support for the #error and appagna directives, the "stringizing" directive #, and the concatenation directive ##. Besides the original K&R escape sequences (such as \n), two new ones have been added: \a to ring the system bell, and

\v to generate vertical tabs.

#include MACRONAME

There are five new predefined macros DATE TIME FILE
LINE and STDC (used to
indicate that an implementation conforms to STandarD C). Finally, a C compiler's preprocessor must support the concatenation of adjacent string literals and the new syntax for the #include directive, where the name of the file to be included may be a macro.

Quick C \$99.00	ECO-C88 \$99.95	Turbo C \$99 95	Watcom C \$295.00	Microsoft C \$450.00	C85Plus \$497,00	Aztec C86 \$499,00	Lattice C \$500 00	High C \$595,00
Implemented	Not available	Implemented	Implemented	Implemented	Implemented	Reserved by compiler	Implemented	Implemented
Implemented	Implemented	Implemented	Implemented	Implemented	implemented	implemented	Implemented	Implemented
Implemented	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented
Implemented	Not available	Implemented	implemented	Implemented	Implemented	Implemented	Not available	Implemented
0	0	•	•	•	•	•	0	0
•	0	10.	•	•	•	•	0	0.
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Pointer's ANSI-compatible compilers must support generic pointers (designated by void *), the ability to assign a pointer to integer 0 (all compilers reviewed here do), and the new notation for pointers to functions. For example.

is a function returning int (*y)(); /* y is a pointer to such a function

y - 4x; /* y

now points to

K&R allowed this

standard C also allows this

Note that when used, the notation for calling either x or y is indistinguishable: you cannot tell whether y is a pointer to a function or a function itself.

(continues)



Header Files with Macros and Library Functions The ANSI draft delines e standard function library. Each function in the library has a prototype that should be found in a specific header (+) file. In addition, these header files should include macros, objects, and type profability for programs written to conform to the standard.

While the headers and objects are not required to be supported until the standard is final, many have been in the standard is final, many have been in the direct for some firms and are no longer subject to change. The compilers were chocked to see fithey provide each of the 15 required header files. Then each header files was checked to listed out what percentage of the more checked to listed out what percentage of the more than 200 prototypes and declarations could be found in the correct header file. (In the ballow, a pick answer indicates nearly 100 and 100 provides and 100 provides and 100 prototypes and ballow, a pick answer indicates nearly 100 prototypes.)

One of the most valueble tools provided by standard C, function prototyping must be supported by an implementation that claims compatibility, it should include the ability to define functions that accept a variable number of arguments, as well es functions that specifically have no return value (for exemple, vo.i.d, which is supported by all compilers reviewed prep.)

Finally, a number of miscellaneous learner required by the standard flustrale a vendor's sensitivity toward the C compler user's you. These are fleatures not very obvious and can be subtry overfooked. All the C complers we've included here let you use the same name for two members of different structures (that is, distinct structure' structures (that is, distinct structure' structures assignment as a means of initializing a structure. — "Richard Hele Shaw

ANSI C Compatibility: Summary of Features (Products listed in accending price order)

POINTERS

Let's C

\$75.00

0

0

\$19.95

DeSmet DC88

\$99.00

void * is valid representation	•	0	•	
Pointers to functions				
func () available (new syntax)	•	0		
HEADER FILES AND				
LIBRARY FUNCTIONS				-
ASSERTH	•	•	•	
CTYPEH	•	>50%	•	
ERNO.H	•	0	0	
FLOAT.H	•	0	•	
LIMITS.H	•	0	•	
LOCALE.H	<50%	0	0	
MATHLH	•	•	>50%	
SETJMPH	•	<50%	•	
SIGNALH	•	0	0	
STDARG.H	•	0	•	
STDDEFH	•	0	0	
STDIO.H	•	<50%	>50%	
STDLIB.H	>50%	0	<50%	
STRING.H	•	0	>50%	
TIMEH		>50%	0	
MISCELLANEOUS				
Function prototyping	•	0	•	
"" supported for variable argument functions	•	0	•	
identifiers significant to 31 characters	•	0	•	
Integer type modifiers, signed/unsigned				
char	••	••	0.	
short	••	••	00	
int				
	••	••	0.	
long	••	••	00	
long long double allowed				
	••	••	00	
long double allowed	:	:	00	

eting-point constants require T/f

ewitch can use any integer type

Quick C \$99 00	ECO-C88 \$99.95	Turbo C \$99 95	Watcom C \$295.00	Microsoft C \$450 00	C86Plus \$49700	Artec C86 \$499.00	Lattice C \$500.00	High C \$595.00
•	0	•	•	•	•	•	•	•
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•	•	•	•	•	•	•	•	•
:	:	•		•	•	•	- 6	å
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10/				Ď.				
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•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
•		•	•	•	•	•	50%	-50%
•		•	•	•	•	•		•
>50%		- 50%	-50%	>50%	•	-50%		•
•	>50%	•	•	•	-50%	< 50%	>50%	-50%
>50%	>50%	:	•	>50%	-50%	0	< 50% > 50%	-50% -50%
-00%	0	-50%		>50%	50%		50%	-50%
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						11		
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While many of the compilers reviewed here have already implemented a large portion of the Draft, others, Let's C for instance, make no pretensions about being ANSI compatible.

A compiler's ability to produce efficient, optimal code is of prime importance. We chose not to use benchmark to test (such as the Sieve of Erastothanes) commonly used by other publications. Instead, PC Labs created four benchmarkprograms that exercise C compilers in the same fashion as you yourself might compiling and running programs that take as, and integer and floating-point math. The benchmark tess assume that most compilbenchmark tess assume that most compil-

Most compilers that generate efficient code also offer a high degree of ANSI compatibility.

ers can optimize well-written code; they imitate the coding habits of a less experienced programmer and test a compiler's ability to effectively optimize code that wasn't well written from the start.

DeSme DCS8, as mentioned previousby, was the fastes to compile the source code of the benchmark tests. However, it was not measured against the in-RAM complations of Turbo C, Quick C, and Waccom Express C. Manx Software's Artec C66 produced the smallest executable old across the board. As for the execution times of the resulting code, the most nodations of the resulting code, the most nodaconsistently second in the top three, and Microsoft C S.1, which always scored in the top four.

Interestingly, most compilers that generate relatively efficient code also offer a high degree of compatibility with the ANSI Standard Draft. And these compilers were often the slowest to compile the benchmark test source code—not at all surprising, considering the number of

ANSI type-checking and code optimizations that have to be performed.

Next, we evaluated each compiler's user interface. The introduction of Turbo C a year ago forced compiler vendors to revaluate this aspect of their product. Microsoft and Watcom offer companion products (Quick C and Watcom Express C) that produce an integrated environment similar to Turbo C's. Other programs, ECO-C88 for example, minim Turbo C's integrated environment. Other companies have yet to respond.

We also considered whether a sourcelevel debugger) came with the program. There's no reason for a programmer to use SYMDEB of DEBUG when a CodeView-like source-code changer is included. Again, Wastom C 6.5 and Microsoft C 5.1 Bed the way, with Quick C, Wastom Express. C, DeSmet DC88, Astec C88, Let's C, Power C, and ECOC-SN not for behind.

It should be noted that one of the compilers reviewed is a special case. NOP C-386, from MicroWay, produces code for the 80386 protected mode; it requires the Phar Lap 386/00-5-Extender and 2MB of memory. As such, it differed so much that we felt it could not be compared with the other compilers in the features table or in the benchmark tests.

A LOOK TO THE FUTURE I recently saked Dennis Ritchin how he fet about the ANSI standardization effort. He admitted that though the ladbeen initially apprehensive, he thought the Committee ought to be commended for a job well done. He did say that he still had some reservations about the const keyword, since it had originally been meant to designate data stored in ROM but has since come to represent any data that cannot be written upon—a related but dual meanine.

Ritchie indicated that a certain stasis may come to C, since "the implementation of function prototypes has actually created, in essence, two languages." New code won't compile under old compilers, he said, and, in some cases, old code won't compile under the new. In "The C Mystique." elsewhere in this issue, Charles Petzold also hints that C may become static." a standardized language is a language that full no longer grow.

Indeed, Ritchie admitted that he would like to have seen the FORTRAN facility of dynamic arrays added to C, but warned that the design of C wouldn't conveniently allow it

anow it.

Perhaps the next trend in the evolution of this wonderful programming language will be for someone to rethink the assumptions upon which C is based. That just might be one of the design goals for the author of "D."—Richard Hale Shaw

Aztec C86

One of the older C compilers for the PC, Manx Software Systems' Aztec C86, Version 4.10c, is still competing with the new kids on the block. Although this old competitor lacks pull-down menus and an integrated editor/compiler, it still has something to offer.

The 5499 commercial edition fine easily not five disks that are stuffed into one IBM-style three-ring binder. Included with the complete is an extensive MAKE utility, an ascembler, a library utility, the barrier of the control of the complete and the state of the s

Although strictly command-line-oriented, the complet itself is surprisingly good. Compilation is swift, generating small, reasonably fact executable files. A few of the common enhancements such as interrupt functions and register pseudovariables are missing, but most of the ANSI dark standard is present. For example, Aster C68 is one of the few compilers to properly handle the # and ## preprocessor tokens.

Aziec C86 is very good about interpreting prototypes and detecting type changes, but, surprisingly, it does not understand prototype ellipses. It accepts both the const and volatile storage classes, although const seems to have no effect.

Aztec C86 accepts in-line assembly language without special provisions. Manx is working to make the libraries match the competition's, but several functions are still missing, most notably those dealing

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FACT FILE



Aztec C86, Version 4.10c Manx Software Systems P.O. Box 55 Shrewsbury, NJ 07701 (800) 221-0440 List Price: \$499 Requires: 256K RAM,

with DOS directories and files.

Included on the distribution disk is a READ.ME file with last-minute changes and updates to the manual. Manx is to be commended, however, for including a list of known bugs. All compilers have bugs, and knowing what they are in advance can save you hours of confusion.

UNN EDITOR The Azec Zőó editor is straigh Unix vi, except that you can use the function keys and the arrow keys in place of vi's inance commands, if desired. Manc has integrated the compiler, the assembler, and the linker. One simple command takes the source C program all the way to an executable LEM file. The original of the area utility is supplied to convert Azec are utility is supplied to convert Azec man for inking via the DOS linker with the output of other commilers.

The debuggers is of the source code variety, but it's not window oriented. The source code listing scrolls off the screen, you must periodically restore it by using a list command. The debugger supports all the expected features, such as permanent and temporary breakpoints, such passes and temporary breakpoints, such passes and sasembly language or source-level debugging.

FRACTURED MANUAL Partly because of age and partly because Manx apparently shares parts of the manual with compilers

for other environments, the Astre C86 manual is fractured and difficult to use updates in reverse chronological order, like fossil layers. Overviews of the complex, assembler, linker, and so forth follow, divided from each other so that they can be combined in different ways for different packages. This arrangement makes for some confusion—for example, no mention is made in the discussion of the work of the complex of the confusion of the control of the confusion of the confusi

The documentation on the library is evenly divided into System Dependent and System Independent sections, but when you want to look up a function, you often don't know to which category it belongs. Since page numbers start over with each section, finding items is difficult even when the index does list them. Dividers would help, but a better solution would be to integrate the manual's parts into a unified whole.

Azer C86 also cones in two less-espensive versions. The Developer system does not include the property of the contraction of the contraction of the conport, the Professional system removes the profiler and the Compact and Medium model libraries as well. Despite its age, with the help of a new manual and an expanded software library, Azer C86 could still connecte. Setopher Randy Davis

C86Plus

"The king is dead! Long live the king!" can also be said about C86Plus, Version 1.1—Computer Innovations' \$497 C compiler.

Computer Innovations (CI) was one of the major players back when the game of hosting C on the PC was still young. Then, C compliers were invariably crude and un-reliable; most didn't even implement the full language. By comparison, CI's C86 compiler was stable and polished. Sure, it was more expensive, but if you intended to do serious development work, you paid the extra case.

Times have changed, and so have users' expectations. Old-time compilers are finding it difficult to keep page. The ANSI





C86Plus, Version 1.1 Computer Innovations 980 Shrewsbury Ave. Tinton Falls, NJ 07724 (800) 922-0169 (201) 542-5920 List Price: \$497

But reve. 597
Requires: \$12K RAM, hard disk, DOS 2.1 or later.

Bishort: Although it's trying hard to keep up with an evolving ANSI C standard, C86Plas still has its rough spots, slow complation with medicare code generation, for example. However, C86Plas is highly complete bile with earlier versions of C86. Not copy

protected. CIRCLE 601 ON PEADER SERVICE CARD

C-standard C86Plus resembles the beloved K&R C86 of old, but new pretenders have come to claim the throne.

C86Plus arrives on seven floopy disks. tucked away into two smallish IBM-style three-ring binders. One of these binders contains a description of the library, the other an overview of the compiler itself. Although the documentation is well written and the description of the library is adequate, the compiler manual is extremely terse. In keeping with its original image as a "professional" compiler, C86Plus has no manual tutorial, nor any but the most compact descriptions of C or C86Plus. An extensive on-line help program is available, though, as well as a help switch on the compiler itself, for a brief review of the legal switches.

Installing the compiler onto a hard disk (you must have a hard disk, with a minimum of 512K) is a breeze. You select the destination directory name and the memory models to install; the installation program takes it from there. You can also install the source code to the libraries.

C86Plus is executed strictly from the command line. Operation is much like that of Unix's CC compiler. Enter "CC" followed by the name of the C source programs, and C86Plus automatically performs compilations and linking. Switches control C86Plus's operation, allowing, for instance, the generation of real-mode 286 or 386 instructions. You can store these Business Forms That Mean Business

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OUR CONTRIBUTORS

Stephen Randy Davis has been a microcomputer programmer for 10 years. He is the author of Turbo C: The Art of Advanced Program Design, Optimization and Debugging (M&T Books, 1988) and is a frequent contributor to PC Magazine. Ray Duncan, a contributing editor of PC Magazine, writes the Power Programmine column. He is the author of Advanced MS-DOS (Microsoft Press, 1986) and Advanced OS/2 (Microsoft Press, scheduled for publication in fall 1988). Ross M. Greenberg is the owner of a New York City consulting firm that specializes in MS-DOS and Unix programming in the C language. He has written

communications programs in C for the Pamela J. Milland is a project leader in PC Labs

past 5 years.

Charles Petzold, a contributing editor of PC Magazine, writes the Environments column. He has been a professional programmer since 1971 and is the author of Programming Windows (Microsoft Press, 1988) and Programming the OS/2 Presentation Manager (Microsoft Press, scheduled for publication in fall 1988). Vincent Puglia, president of PLS Consulting Services in Lindenhurst, New York, has written programs for both mainframes and PCs. He is familiar with many third-generation languages, including C, PL/1, COBOL, Pascal, and BASIG

Richard Hale Shaw, a contributing editor of PC Magazine, edits the C submissions to the Languages column, and has been programming in C for 4 years. He is also a software engineer at Hilgraeve Inc. FACT FILE DeSmet DC88

DeSmet DC88

Version 3.1 CWan P.O. Box 428 Paso Robles, CA 93447 (805) 239-4620 List Price: \$99 Requires: 192K RAM.

DOS 1 flor later In Short: A complete development system with editor, compiler, assembler, linker, debusiner, and software took including execu tion profiler. Limited mostly to small-model code generation, but including the fastest compiles in the West. Not copy protected. CIRCLE MICON READER SERVICE CAR

Mark DeSmet, a consultant to Intel, De-Smet DC88 produces code for what is popularly known as the small model; that is, no more than 128K of memory-64K for code and 64K for combined data, heap, and stack space-can ever be used. While the package offers stopgap measures for allowing greater code space (overlays) and has a large-case option for producing large model code, its greatest strength is also its greatest weakness: the compiler primarily produces small-model code for small and medium-size applications, including softsware tools

This simplifies everything about the compiler. Since only one model is supported, you won't have to worry about which one to choose. This has also allowed C Ware to optimize the compiler and simplify the assumptions that the compiler must make about the code it generates. So it should come as no surprise that DeSmet DC88 compiled the PC Labs benchmark tests faster than any other disk-based compiler tested.

DEMANDING INSTALLATION While DeSmet DC88 is relatively easy to install, I found that the process demands more than you might expect; it certainly can be timeconsuming. The software arrives archived on three disks, and you must manually copy it from the disks and unarchive it. If you have the disk space, it's simpler to unarchive the whole thing and delete what you're not going to use. Also, you must

switches into environment variables alone with the include file and library paths for automatic recall

A limited MAKE capability keeps C86Plus from compiling source files that have not changed. A separate MAKE utility allows you to spell out detailed dependency relations in a project file for serious development. A library utility also comes with it, but there's no debugger or editor.

SLUGGISH EXECUTION C86Plus's execution is sluggish; the compiler routinely performs near the bottom of the list of compilers tested. The resulting programs were never the worst performers tested, but they were always behind the pack. And while C86Plus implements the vast majority of the ANSI draft standard, it is not without flaws. Version 1.1 had several bugs-for example, accepting a long argument to a switch statement, but then generating code that caused a crash. Even CI's standard stdio.h include file routinely generated a spurious warning message during compilation

C86Plus supports the ANSI C draft standard. It also supports common extensions such as the near and far pointers. but not HUGE. Features missing include interrupt procedure types, in-line assembly language, and direct access to the registers. While retaining as much compatibility as possible with C86, the C86Plus library has adapted quite well to the ANSI standard. Missing, however, are support for windowing or graphics or for devices such as a mouse

You can work around most of C86Plus's problems. The bugs we encountered were not serious, and you could add the missing features in the library. And C86Plus will work with other vendors' editors and debuggers.

-Stephen Randy Davis

DeSmet DC88

DeSmet DC88, Version 3.1, from C Ware, is a lean, mean, high-quality C development package that puts compilation speed ahead of nearly every other feature. Offering a program editor, assembler, compiler, linker, and source-code debugger, DeSmet DC88 also sports a package of excellent programmer's utilities. The \$99 program is designed for the C programmer who prefers writing small applications, utilities, and software tools Originally written and developed by

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A GLOSSARY OF C LANGUAGE TERMS

Array A collection of data items of the same type. An array may be accessed by an index. Arrays may have one or more dimensions, and multidimensional arrays usually represent tables. A simple array might contain values for the days of the week.

C data types C allows five basic data types: 1. char (character): ASCII characters

2. int (integer): integer numbers

float: floating-point, or real numbers

4. double: large floating-point numbers 5. void: recently added by ANSI as part of the proposed C standard, void may either declare a function as returning no value or may be used to create generic

C operators An operator tells a computer to perform a specific operating such as multiplication, division, or determining a statement as true or false. Besides the usual mathematical functions. C uses increment (++, which adds I to a number's operand), decrement (--, subtracts I), and a number of logical and relational operators. C is known for the versatility of its operators.

Code block A series of statements, en-

closed within braces, or { }, that execute together as a unit.

Compiler Translates program source code into object code. Since a computer can execute object code directly, compiled programs run more quickly than interpreted programs.

Functions As independent subroutines, functions allow modular program creation. The main program will contain calls to functions, which then perform operations, return values, call other functions, and generally act as very simple standalone programs. Extensive use of functions increases portability.

Interpreter Reads and executes program source code line by line, without generating intermediate object code. Many C programmers use an interpreter as an interactive debugging tool, which enables them to view a program while it is executing.

is executing.

Library C compilers have standard libraries consisting of functions used to perform commonaly required tasks and I/O operations. A hallmark of a good compiler is the richness of its libraries. Linker Combiness program code with functions found in the C compiler's libraries. Some C vendors supoly linkers:

others use operating system linkers, such as DOS LINK.EXE.

Pointer A variable that contains a memory address. A key element in the efficiency of C, pointers allow a programmer to indirectly access the contents of a variable at a memory address. Program control statements C con-

ains a variety of statements that regular the flow of a program. The WHILE, FOR, and DOWHILE statements control program tops, and GOTO, CONTINUE, and RERAM affect where, how, and whether a loop or statement will continue. The library function, exit(), terminates the program and result of the program and results of the program and resu

clared as register, instructing the compiler to keep the value of these variables in the register of the CPU rather than in memory, where variables are conveniously stored. Operations performed on register variables are therefore very fast variables are therefore very fast variables are therefore very fast variables. Of cediarse variables, in function gramaters (formal parameters), and throughout the program (global variables)—Pamela J. Milland

make your own decisions as to what kind of directory structure you'll use and which files go in which directory. There's no installation program included that would automate this work for you.

C Ware does provide a fine full-screen programe dition, SEE, that can run the compiler and linker without your having to exit to DOS. Also available is the ASM88 assembler, which uses a subset of MASM instructions. Again, it's very fast since all data and code references can be assumed to be 2 bytes long (for the small model). Among DeSmet DC88's features, a fa-

Among DeSmet DC-88's teatures, a favorite of mine is its ability to handle in-line assembler, embedded in the source code. This is accomplished by using some additional preprocessor directives, #asm and #, respectively. The compiler assumes that any lines falling between these two

directives is assembly language. In addition, the compiler has a convenient way of accessing the registers of the 8088—by using pseudoregisters. While not as versatile as the pseudoregisters found in *Turbo C*, they're easy to use.

NO COMPILE-LINK DRIVER One problem I found with DeSmet DC88 is its lack of a driver program for executing the compile-link process. While the program contains instructions for creating a batch file that executes separate compile and link commands, a smart program would be more appropriate.

Included with the DeSmet DC88 package is a source-level debugger, D88. With a simple but powerful interface, D88 displays the source code of the function being executed, lets you set breakpoints by ad-

dress or line number, and allows you to watch the contents of local and global variables as the program executes. In addition, D88 evaluates the result of C expressions and displays the elements of an array or structure.

Like some of the other compilers reviewed in this issue, DeSmer DC88 includes a number of software tools and utilises. It is virtually the only compiler to the compiler of the compiler of the compiler and package. For officers measure how much program execution profiler as part of the standard package. For officers measure how much program covered to the compiler of the code is being used the

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most, allowing you to concentrate your optimization efforts.

Generally, DeSimet DC888 is a fine complier with a few minor deficiencies. First is its lack of a compilation-link driver. Secnici, tues a projectively linker and objecttile format, although a DC55-Link options: Third, the documentation has no index. And, finally, the executable code is no particularly fast. This is partly due to be lack of optimization performed by the compiler: you trade code optimization for fast compilation. But if you've looking for fast compilation. But if you've looking for and a nice debuserer, this is it.

-Richard Hale Shaw

ECO-C88

ECO-C88, Version 4.0 (\$99.95 from Ecosoft), is a Compiler for the C novice. Featuring a six-pass compiler, editor, sourcecode debugger, and many tools and features that professional programmers look for in a C compiler, ECO-C88 furnishes an environment where a novice can learn and grow.

Jack Purdum, the president of Ecosoft, is the author of the Programming Guide, probably the first book other than the original K&R to plumb the depths of the Clanguage (K&R seemed quite incomprehensible to many in those days). For those of us to whom learning C was a long, difficult struggle, Purdum's books were a beacon of light in the darkness. ECO-C88 fits into the same niche the same niche.

Installing ECO-C88 is easy. An installation program prompts you for the appropriate disks, makes directories, and installs the compiler without modifying either AUTOEXEC.BAT or CONFIG.SYS. In addition, a README.DOC file containing undocumented changes is displayed at the end

One of the first things I noticed when using ECO-C&B is what's known as the "picky" flag. This compiler command-line flag lets you control compilation with up to ten levels of warnings/error-checking. While Purdum agreed that level 2 was good for everyday work, he warned, "we've yet to see any published code get past level 9" on the first try. Frankly, I believe him.



An interesting aspect of ECO-C88 is and the CC-EXE, the driver program for the compiler, comes with complete source code, allowing you to modify it or even create your own interface to the compiler. Although the Medical Program of the Company of

While the standard CC-command-line interface is available, ECO-C88 comes with an editor, CED, that lets you run the compiler without exiting to DOS. CED includes keyboard macros, on-line help with function prototypes, and a brief description of each library function.

While CED comes set up to work like WordStar, its keyboard, tabs, colors, and indentation are completely configurable. It also allows you to save and restore the entire work environment, including the file you're working on, your cursor location in the file, and parameters you want passed to the compiler.

ECO-C88 also comes with a sourcelevel debugger, CMORE, which allows you to set tracepoints and multiple breakpoints on function calls, addresses, and loop iterations. In addition, you can format output to the Trace window as if you were using printf().

LIBRAW The ECO-CSS routine is brown jendous must of the capscud C library functions, with a few additions, while the library doesn't have graphics functions (graphics and windows package are available for about \$40 each, bid does have character-mode screen 10 functions, or a construction of the control of

While ECO-C88 seems to be directed to the C novice, it's also suitable for the novice programmer: the complete error messages look as if a human being, not a computer, were writing them to you. Other aspects of ECO-C88 seem to indicate this, too. For example, the mal Juc (1) and free (1) library functions automatically switch to allocating memory from DOS if there is no local heap space available.

WHAT'S MISSING Unfortunately, in Ecosoft's zeal to make ECO-C88 easy to use, the company seems to have overlooked a few things. For instance, I could not find any mention in the manual of what the compiler's setup requirements were: the minimum RAM, how many drives are required, and so forth. I found numerous typos and mistakes in the manual, and I didn't care for the way the library descriptions were handled (I prefer the standard "one function per page, function name at the top of the page" descriptions in the traditional Unix style). Nor did the library descriptions include prototypes or return types for each function.

While I found CED easy to install, use, and configure, the lack of integration between it and the compiler can be annoying. Since the editor and the compiler are truly separate programs, you must save your file before compiling it: the compiler reads the source code from the disk and not from CED's buffer.

ECO-C88 is largely ANSI C compatible. Function prototypes are supported, and so is structure assignment. Long identifiers are supported (up to 30 characters), as is variable argument processing (in varargs.h). Unfortunately, there doesn't seem to be any support for the ANSI predefined macro names (__FILE___, for example), nor for most of the other new preprocessor additions.

ECO-C88 goes nicely with Dr. Purdum's books, and I would not hesitate to recommend it to a person new to C or to programming. Indeed, Heath-Zenith is using it as the basis for a training package on C. Already an excellent value, ECO-C88 could pack even more bang for the beginner's buck with some minor improvements.—Richard Hale Shaw

High C High C/386

High C and High C/386, from MetaWare (\$595 and \$895, respectively), are full-fledged professional C compilers designed for the serious program developer. While they don't sport the extra fills of an editor and debugger, they do offer a variety of code-generation options, near-ANSI-standard compatibility, and a variety of unusual, albeit noportable, extensions to the C

language. While these two compilers have identical user interfaces, function libraties, and cutumistions, the code they generate differs considered to the properties of the code for the Intel[®] (1866, 1801, 1802, 1803, 180

High C installs with ease. All the programs are stored in a packed archive file on several disks. The installation program alters neither your AUTOEXEC.BAT nor your CONFIG.SYS, since environmental variables are not necessary for the compiler to run. Instead, the installation program sets up a complex subdirectory structure under the directory you specify for High C. and all the support files and programs are placed in the appropriate subdirectory automatically. While this makes installation simple, each of the compiler components, header files, and so forth must remain in the appropriate directory for the compiler to run

The documentation that comes with High C is clean, well laid out, and well organized. The indexes are extensive, and it's easy to find almost anything. However, I did notice that some of the indexes need updating; references are sometimes one or two pages off.

EXTENSIONS Some of High C's more-interesting aspects are its extensions to the C language, most of them Pascallike (not surprising, since MetaWare also produces a full-featured Pascal compiler). Among them are nested functions and the ability to introduce ranges in the case of a switch statement.

Other extensions include the ability to use an underscore in place of commas in constants (for readability), intermixed declarations and statements within a function (standard C allows declarations only at the beginning of a function or a block), and derivatives of C compilation directives. An example of the latter, #e_include, works just like #include except that it

While constructs such as these are not portable and certainly do not conform to the emerging standard, you can enforce ANSI compatibility by using a complex switch. Furthermore, MetaVare's extensive Language Reference Guide shows exclicitly what part of the emerging standard it does or does not support, and which of the extensions are not portable.

excludes a previously included file.

IN CONTROL In addition, a number of pragmas are available for controlling compilation and code generation. They allow you to specify function-calling conventions, control function parameter passing, determine whether the caller or the call recipient performs stack cleanup after a function call, and specify functions such as FAR or NEAR routines. There are pragmas for designating interrupt handlers. saving registers on entry to a function, specifying routines that return 32-bit values, and generally configuring the compiler. While some of them are equivalent to mechanisms used by other compilers, such as the pascal keyword in Microsoft C. they are infinitely more flexible.

And, white other compilers may claim that they produce code for the NEC V-20 and V-30 processors (used in the NEC ers, but you even have the option of mak-



MultiSpeed), this is the only compiler I'm aware of that generates code that can take advantage of the additional registers available on those processors.

CIPICLE 678 ON PEACER SERVICE CAR

High C (incidentally, the compiler used to produce dBASE III Plus) performs most of the optimizations specified in our C compiler features table, but I had hoped it would produce smaller, faster code than it did in the PC Labs benchmark tests.

The High C runtime library is close to ANSI C standard, but not particularly robust. Many of the extra and unusual functions found in other compilers' libraries were missing.

were missing. C keywords count and volatile are supported but do not yet appear in the documentation. Surprisingly, the entry keyword, dropped by the ANSI C Standard Committee, is still mented in the documentation. High C suptomed in the documentation. High C suptome D support of the Committee of th

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motherboard. Motherboard accommodates up to 4MB onboard RAM using 80NS 1 MB dram's

☐ Hard drive and floppy drive controller ☐Samsung amber monochrome

□200 watt power supply □1.2MB high density floppy drive

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HD/FD controller

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200 watt power sup □ Bohanced 101 key keyboard □ AT style case with LED's for hard drive, power, and turbo

setting □1.2MB high density floppy drive

EGA SYSTEMS: NEC Multisyne II Monitor and Paradise EGA card Add: \$684 Basic EGA System including Monitor and EGA card Add:\$399

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■ C COMPILERS

W.C.LTME	Pewer C \$19.95	Laf's C \$75.00	DaSmel DC88 \$99.00	Quick C	ECO-C88 \$99.95	Tarbe C \$99.95	Walcom C \$295.00	Microsoft C \$450.00
GENERAL FEATURES				******				
Operating environment	DOS	DOS	DOS	DOS	DOS, OS/2	DOS	DOS	DOS, OS/2
No. of diskettes	2	5	6	6	7	5	8	14
Storage required on hard disk	747K	1.2MB	250K	1MB	700K	200K	2.8MB	5.3MB
Minimum RAM required	320K	320K	256K	448K	512K	384K	512K	400K
Runs on dual-floppy computer without disk exchange	0	0	•	•	0	•	0	0
INSTALLATION								
Automatic install program	•	•	0	•	•	•	0	•
Automatically sets up directories	•	•	0	•	0	•	•	•
Sets path to libraries and linker	•	•	0	0	0	0	•	•
COMPILER								
Error handling								
Checks for multiple errors	•	•	•	•	•	•	•	•
Provides multiple warning levels	•	0	0	•	•	•	•	•
Checks for ANSI C compatibility	•	0	0	•	•	•	0	•
In-line features								-
8067/80287/80367 support	0	0	0	•	0	•	•	•
80188/80198/80286 support	0	•	0	•	0	•	•	•
User functions	0	0	0	•	•	•	•	•
Memory models supported								
Small (64K code, 64K data)	0	•	•	•	•	•	•	•
Medium (unlimited code, 64K data)	•	0	0	•	•	•	•	•
Compact (64K code, unlimited data)	0	0	0	•	•	•	•	•
Large (unlimited code, data)	0	•	•	•	•	•	•	•
Huge (with arrays larger than 64K)	0	0	0	0	0	•	•	•
Optimizations								
For speed	•	0	0	•	0	•	•	•
For size	0	0	0	•	•	•	•	•
Selective disabiling	0	•	0	•	0	•	•	•
Constant folding	•	•	0	•	•	•	•	•
Extra jump elimination	•	•	0	•	•	•	•	•
Invariant code reduction	0	•	0	•	0	0	0	•
Empty loop elimination	0	•	0	•	0	0	0	•
Register variable allocation	•	•	0	•	.0	•	•	•
Register variable reallocation	0	0	0	•	0	•	•	•
Common subexpression elimination	0	•	0	•	0	0	•	•
Idiomatic code replaced with special instructions	0	0	0	0	0	0	•	•
Other peephole optimizations	•	0	0	•	0	•	•	•
Disable stack-checking	•	0	0	•	0	•	•	•
Disable null pointer checks	0	Ω	Ω	•	0	•	•	•

C86Plus Artec C86 Lattice C High C S49700 S599.00 S595.00 S995.00 DOS DOS DOS DOS, OS-2, Microsoft S
Microsoft 5
Windows
7 5 5 7
19MB 13MB 720K 2MB
512K 256K 256K 320K
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0 0 0
make the second

ing all the characters in an identifier signifant (as in Berkeley Unix).

High C is a professional's C compiler, although I would prefer some improvement in the compile and run times. If you ike flexibility, need to generate code for specific Intel processors, or would like to ee some Pascal-like extensions available n C. High C might be the compiler for ou.—Richard Hale Shaw

Lattice C

Only a few years ago, there were two prinipal players in the C compiler marketplace: Lattice C-and everyone else. Since then, Microsoft, Borland, and others have carved out their own market niches. encroaching on the turf that was once con-

Today. Lattice C is a product in a state of transition. While Version 3.21 was available when I wrote this review, 3.3 is scheduled for release before you read this. and Version 4.0 should follow a few months later. Why the "versionitis"? The answer should be apparent after reading this review: the Lattice C compiler, though solid and reliable, is overpriced and underfeatured compared with its competition.

Installation of Lattice C is easy; there's almost nothing to it. The installation program (not a .BAT file) will prompt you for a target directory to install the compiler, build the required subdirectories, and copy the appropriate files to your disk. Both 51/4- and 31/2-inch disks are contained in the package.

The Lattice C documentation comes in two cleanly typeset, spiral-bound volumes, encased in hard covers to make them durable and easy to use. The first volume includes a language reference guide, discussions of the supported memory models, and instructions for using the compiler itself. The second contains descriptions of the runtime library functions and listings of all of the header files. The function descriptions are particularly well done: each function begins on its own page, complete with name, synopsis, header file, function description, return value, references, and examples. In addition, a label identifies a function as originating in the ANSI standard or in the Lattice C library-in all, some of the best

library documentation I've seen.

Unfortunately, while each section of the manuals has its own table of contents, the only index I could find was for functions in the runtime library. There is simply no comprehensive index, which makes it difficult to find particular subjects. In addition, there's no list of library functions by classification (for example, a list containing all the string-handling functions in one group, the file-handling functions in another group, and so on).

ANSI C COMPATIBILITY? Lattice was originally known for its various crosscompiler implementations. The company produced compilers for many of the major mainframe and miniframe processors, not to mention micros; it was the first to offer a C compiler on the Amiga. In the spring of 1987. Lattice was purchased by SAS Institute, which saw it as an opportunity to acquire and market compiler technology under its own acgis. SAS even replaced Lattice's representative on the ANSI committee with one of its own people, although this may have had the unfortunate effect of placing Lattice further behind in the effort to maintain ANSI compatibility.

This becomes more obvious when you consider the scarce references to the emerging ANSI standard in the documentation, making it difficult to determine the ANSI compatibility of the compiler. While function prototypes and other, better-known ANSI devices are supported.



ities that a professional would expect for the price tag. While upcoming versions may remedy this, look elsewhere if you need a werful compiler now. Not copy protected CIRCLE #77 ON PEACER SERVICE CASE

■ C COMPILERS

(Products listed in ascending price order)	Power C	Lers C	DeSmet OC88	Quick C	ECO-C88	Turbo C	Watcom C	Microsoft C
MAINTENANCE FEATURES	\$19.95	\$75.00	\$99.00	\$99.00	\$99.95	\$99.95	\$295.00	\$450.00
MAKE (source-code maintenance)	0	•	0	•	O.	•	•	•
Applicable to other languages	N/A	0	NA	0	N/A	0	•	•
Maintains system based on date	N/A	•	NA	•	N/A	•	•	•
Organized by project	N/A	•	N/A	0	NA	•	•	0
DEBUGGER (SOURCE-LEVEL)								
Pracing	•	•	•	•	•	0	•	•
Start/stop after specified occurrences	•	•	•	0	•	N/A	•	0
Start/stop based on a condition	•	•	0	•	•	N/A	•	•
Lists line numbers	0	0	•	•	0	N/A	0	•
Breakpoints								
Enable/disable efter specified occurrences	0	0	•	•	•	N/A	•	•
Enable disable based on a condition	0	0	•	•	•	N/A	•	•
LINKER, LIBRARIAN, OBJECT FILE SUPPORT								
Standalone linker included		0	•	•	0	•	•	•
Uses DOS's LINK.EXE	0	•	•	•	•	•	0	•
Standslone Ribrarian included	0	•	0	0	0	0	•	0
Uses Microsoft LIB utility	0	•	0	•	•	0	0	•
Proprietary object file format	•	0	•	0	0	0	0	0
EDITING FEATURES								
iditor	None	Standatione	Standalone	integrated	Standalone [†]	Integrated	Standalone	Standalone
Mouse support	NA	0	0		0	0	•	0
Supports 43-line EGA	N/A	Ö	0	•	0	•	•	•
Maximum number of files	N/A	11	2	Unlimited	2	Unlimited	64K	Unlimited
Seerch and replace	N/A	•	•	•	•	•	•	•
Cut and paste	N/A	•	•		•	•		
Formetting	N/A	0		0	0	0	0	
Parenthesis matching	N/A	0	0	•	0	•	0	0
Keyboard macros	N/A	•	•	0	0	0	•	•
Mecro language	N/A	0	0	0	0	0	0	•
Modifiable by user	NA	0	•	•	•	•	0	•
MODULE INTERACTION								
ntegrated editor/compiler	0		0		Optional		0	0
ntegrated compiler/linker	0	•	o		0	•	Optional	•
MPLEMENTATION-SPECIFIC FEATURES								
dear/far functions		0	0		0			
escal calling conventions	•	Ö	0	•	0	•	•	
rierrupt headings		0	o		Ö	•	•	•
n-line assembler	ō	ŏ	•	0	0	•	0	o .
Mract access to registers	0	0	•	0	0	•	0	0
lear/far pointer types	•	ŏ	ŏ	•	ŏ		•	•
fuge pointer	ō	ŏ	ŏ	•	ŏ	•		
087/10x87 emulation	ě	ě	0		ě	•		

^{*}MAXE leasures are bulk into the comprise. **Can be used as a roandstone action or integrated with the comprise.

85Plus 49700	Aztec C86 \$499.00	Lettice C \$500.00	High C \$595.00
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		N/A	N/A
•	•	N/A	N/A
	•	0	0
A		N/A	N/A
Α	8	N/A	N/A
A	•	N/A	N/A
A		N/A	N/A
A	0	N'A	N/A
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one	Standalone	None	None
A A	0	N/A	N/A N/A
A A		N/A N/A	N/A N/A
A A		N/A	N/A
A	0	N.A	N/A
Α	- 5	N/A	N/A
A	•	N/A	N/A
A	•	N/A	N/A
A		N/A	N/A
`	0	N/A	N/A
	0	0	0
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one cannot help but come to the conclusion that this implementation has paid little more than lip service to the emerging stan-

dard.

The PC Labs benchmark tests show that Version 3.22 of Lattice C is no speed demon; if falls squarely in the center to pack on all compile times. The size of the pack on all compile times. The size of the code generated by the compiler wave age, except for the relatively small floating-point benchmark code size. Financial Code size, Fina

As for other features, Lattice does supply a fine runtime library and was one to the few compilers reviewed that included NetBIOS support functions. All of the major memory models are supported, and Lattice has added a few twists of its own to them. And Lattice's Technical Support Group has earned a superb reputation over the years.

LITTLE BANG FOR THE BUCK Noticaelly lacking from this compiler so source-code debugger, an editor, and support of 8028 proxected mode. For company that has been in the game as long as Lattice has, with a product as with a product as wide known as Lattice C, this compiler simply does not pack the features and options are so readily available from the competition. The axing price of \$500 cannot up to compiler that offer as much or more for one-fifth the call.

Whither the future for Lattice C? As mentioned. Version 3.3 should be available by the time you read this review, and all indications are that it will be a step in the right direction. It should include the ability to run under and generate code for both MS-DOS and OS/2's 80286 protected mode; it also should feature an editor and a debugger for both real and protected mode. ANSI compatibility should be more aggressively addressed and the library expanded. On top of that, the price is being lowered to \$450. This is OK for a protected-mode compiler, but it isn't a major concession; there are feature-packed \$100 compilers reviewed in this issue if you are concerned about price.

In an effort to be even more aggressive,

which will follow 3.3 by a few months, should include an integrated environment, a source-level debugger that will imitate and attempt to surpses Miner that will optionally overlay data, further compliance with ANSI, and (at last) considerable optimizations for improving code size and speed. Additionally, Lattice will be throwing in a number of improved utilities and software tools that currently must be purchased septomber to the state of the property of th

arately.

Lattice's promises do raise questions—one of them the possibility that the versions to come are doment to remain vaporware. Keep in mind, however, that Lattice does have a solid, if staid, reputation. While we all know how unstable reased axes can be, these producers should see that the state of the state

The time it takes Lattice to produce its new versions will be more than enough time for other vendors, whose compliers already surpass Lattice C, to enhance their products even further. But if Lattice's upcoming versions really outclass the competition, it will be worth the wait.

—Richard Hale Shaw

Let's C

Nonconformity might be a desirable trait in a person, but not in a compiler. Let's C. Version 4.0.12, \$75 from Mark Williams Co., is the only compiler we tested that made no attempt at being ANSI compatible. (Mark Williams insists, with some validity, that since ANSI C is only a draft standard, there is currently no standard to suppoort.)

Let's C's nonconformity extends to its 500-page, softbound manual, which contains the five disks. After an initial installation and tutorial section, the manual begins an alphabetically ordered lexicon—everyhing is thrown together strictly on the basis of spelling, Explanations of "switch" (the C primitive), "string company," string in the company of the company of the company of the library function), "stream" (a file concept), and "strip" (a utility supplied by Mark Williams) are contained on consecutive pages because they all begin with the

■ C COMPILERS

C Compilers: Summary of Features (Products listed in ascending price order)

	Power C	Let's C	DC88	Quick C	ECO-C88	Turbe C	Watcom C	Microsoft C
RUNTIME LIBRARIES	\$19.95	\$75.00	\$99.00	\$99.00	\$99.95	\$99.95	\$295.00	\$450.00
String functions								
Substring	•	•	•	•	•	•	0	•
Search string	•	•	•	•	0	•	•	•
Parsing into tokens	•	0	•	•	•	•	•	•
Graphic functions								
Lines	•	0	•	•	0	•	•	•
Circles	•	0	•	•	0	•	•	•
Pies	•	0	0	•	0	•	•	•
Curves	•	0	•	•	0	0	•	•
Elipses	•	0	0	•	0	•	•	•
Rectangles	•	0	•	•	0	•	•	•
Get/set display mode	•	0	•	•	0	•	•	•
Filled objects	•	0	•	0	0	•	•	0
Get/set palette and attributes	•	0	•	•	0	•	•	•
Get/set coordinates	0	0	•	•	0	0	•	•
Save/restore images to/from memory	0	0	•	•	0	0	•	•
File/directory support								
Subdirectory functions	•	0	•	•	•	•	•	•
DOS find first/next functions	•	0	0	•	•	•	•	•
Access to file time/date stamp	•	•	0	•	0	•	•	•
Disk space functions	•	0	- 0	•	0	•	0	•
Devices as logical files	•	•	•	•	0	•	•	•
Get name of current directory	•	0	•	•	•	•	•	•
Change attributes and permission settings	•	0	•	•	•	•	•	•
File locking	•	0	•	•	0	•	•	•
BIOS functions directly available	•	0	•	•	•	•	0	•
Trigonometry routines	•	•	•	•	•	•	•	•
Memory allocation								
Near heap allocation	•	•	•	•	•	•	•	•
Far heap allocation	•	0	•	•	0	•	•	•
Allocation directly from DOS	•	0	0	•	0	•	•	•
Binary search feature	•	0	•	•				
DOCUMENTATION								
Contains Index		•	0	•			•	
Contains glossary			0		ō	0		-
Command-oriented section		o	•		•	•	0	:
Tutorial section	-	•	0	-	0	÷	0	-
Error message section	:		-		-	:	-	-
ANSI C comparative information	0	0	-		-	0	0	-
On-line help	0	•	0		0	•	•	•

PC MAGAZINE SEPTEMBER 13, 1988

66Plus 497.00	Aztec C86 \$499.00	Lattice C \$500,00	High C \$595.00
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letter s. This format is great when you know what you're looking for and you want further explanation. It's not so good when you're searching for a library routine or a command to perform a certain function.

The tutorial section of the manual plus an automatic install program make installation easy. You can install Let's C into any directory with the executable, include, and library files in separate or common directories. The user sets up environment variables to direct Let's C.

The editor is micro-EMACS and is not configurable (source code is included. however)-great if you know EMACS, but otherwise you have a new editor to learn, and this one is even worse than WordStar's. Although they're separate programs, the compiler and the editor are sufficiently tied together so that when the compiler detects an error, it can place the user into the editor with the cursor at the point of the infraction. A special key sequence allows movement forward and backward between errors. When finished, the user types a simple Ctrl-Z key command to exit the editor and start compilation over again from the beginning. Once compilation is successful, the compiler automatically executes the link step to generate a standalone .EXE file.

SHELL Mark Williams supplies an "afterthought" shell program, called MWS. MWS allows items to be selected from menus, including filenames, in typical point-and-shoot fashion. The user watches the commands being built in a window as each option or file is selected. When the user finally selects the Execute option, MWS simply executes the command. Even though context-sensitive help is available from the environment (no help is available from the compiler or the editor), I quickly tired of the shell and began building commands directly. Fortunately, you can store the compiler switches into the environment for automatic execution at compile time.

FEW EXTENSIONS Let's C implements few of the ANSI or the Microsoft extensions to C. Better forget about using near, far, huge, or void pointers, interrupt and pascal function types.



function prototypes, or variable arguments. And Let's C supports only the small and large memory models. No form of in-line assembly language is supported. However, Let's C includes 8087 support libraries, as well as 8018 66 instructions.

libraries, as well as 80186 instructions.

Let's C does support ROMable code
and can be linked with PL/M and compatible languages via an "alien" function
type. Non-K&R constructs can optionally
be flagged with a warning, but turning this
option on generates warnings in the Mark
Williams include files and therefore makes
finding real errors in the editor more diffifinding real errors in the coltro more diffi-

cult.

The custom debugger is of the windowed, cursor, and function-key variety. It offers context-sensitive help, as well as a template that fits neatly over the function keys (provided that your function keys are on the left side of the keyboard). The basic debug features are available.

Let's C is a strange beast in a world of largely ANSI-standard compilers. If you anticipate never changing C compilers nor exchanging programs with anyone else, you might want to consider using Let's C, but I'll stoke with the pack.

-Stephen Randy Davis

Microsoft C

Microsoft C, Version 5.1, Optimizing Compiler, is the quintessential C programming environment. Replete with sourcecode debugger, editor, enhanced linker, object-file library, and source-code maintenance utilities, this compiler offers a

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Microsoft C, Version 5.1 Microsoft Corp. 16011 N.E. 36th Way Box 97017 Redmond, WA 98073-9717 (206) 882-8080

nce, editor, source

List Price: 5450
Requires: 448K RAM (512K recommended), DOS 2.1 or later.
In Short: A professional programmer's development tool, including compiler, linker,

code debugger, Quick C programming environment, and massive runtime library. Can run under and produce programs for either the DOS real-mode or the OS/2 protected-mode environment. Not copy protected.

panoply of features that meet the needs of the most demanding software engineer.

Since its arrival in the C compiler marketplace, each release of Microsoft C has included new utilities and capabilities. Version 3.0 sported enhanced third-party library support, a comprehensive runtime library, and multiple memory models. With Version 4.0 came compatibility with the emerging ANSI-standard, reliable code optimization, and the CodeView debugger. Version 5.0 saw the inclusion of the Quick C compiler and programming environment (reviewed here) and further extensions to the runtime library. In all, Microsoft Corp. has made its C compiler the standard by which all others are compared-and next to which they often pale.

Microsoft C 5.1 offers yet another series of enhancements, including an improved Code View debugger, a sourcecode editor, and the ability to generate code for both the OS/2 and MS-DOS operating environments.

SETTING UP Installation is relatively easy. There are 14 disks in all, and the Setup program asks a number of questions about the directory structure you're going to use, as well as whether you'll be producing code for real mode, protected mode, or both. You're also prompted for your choice of editor configuration and the

mode in which the compiler itself is to run. Setup doesn't alter CONFIG.SYS or AU-TOEXEC.BAT; instead, it creates mockups whose contents you can optionally place in those files.

Microsoft C 5.1's documentation is detailed, comprehensively indexed and well organized. It consists of three manuals: a user guide, a utilities manual, and ereence guide to the runtime library. Included are sections on the use of the compiler and command-line switches, the various memory models, code optimization, ensuring portability, and generating ROMable code. In addition, there are guides to comnode. a complete C Language Reference Guide, and a exclusion for calling and combining code generated by other Microsoft language Compiler.

Surprisingly enough—considering the completeness of the documentation—there is no list of the minimal hardware requirements needed to mut be compiler, except on the outer packaging. While this is true of other C compilers reviewed here, and while every serious C programmer should have a minimum 640K RAM, every vendor should nontheless include this information.

The Run-Time Library Reference manual may be the best I've ever seen. Each function description includes the standard summary (function prototype and appropriate header flies), description, and return values. Most of these contain references to related functions and source-code examples. And every function's entry begins at the top of a fresh page, so it's easy to find.

FLEXIBLE ENVIRONMENT Microgoft C.5.1 supports five memory models in all: small, medium, compact, large, and huge. It will perform a number of optimizations on your code, including effective use of the machine registers. In addition, the compiler can run under and generate code for both the 8088 real-mode family and the 80268 protected-mode environ-

In other words, you can run the compiler under MS-DOS, the OS/2 compatibility box, or an OS/2 protected-mode screen group. If you're running OS/2, it's easier to run the compiler from a screen group rather than in the box: as a protected-mode

application, it can be left compiling in the background while you work on something else. Because the compiler can generate code for either environment, real-mode programs can be run in the box or under MS-DOS.

Included with the compiler is Codel'ew, a source-code debugger that you can use to diagnose and track program errors. Code/lew is a very complete but surprisingly casy-to-use debugger, offering windows that similarmously display program source code, machine registers, and program variables. A Watch window is available are continuous wisein of the beautiful program to the continuous wisein of the beautiful and you can set conditional breakpoints, or watchpoints, to make program pause when the breakpoint condition is true. And

Microsoft C 5.1 will perform a number of optimizations on your code, including effective use of the machine registers.

CodeView's mouse support is what makes the debugger truly shine—its point-andshoot approach makes it a snap to nail

down program bugs.

Previous versions of CodeView have included the ability to forms the output of wachpoins as C data types, but this versions of Code and the code of the co

While CodeView can display the output of complex source-code expressions in C, it's capable of handling expressions in BA-SIC and FORTRAN, too. And a number



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C COMPILERS

of command-line options improve its flexibility. For instance, while CodeView itself takes up a lot of memory, you can debug larger programs by using a command-line switch that relocates the program symbol table to expanded memory, freeing conventional memory. Another switch runs the debugger in 43-line EGA mode, and yet another lets you use two monitors: one for program output, and one for the Code-View screen.

POWERFUL YET QUIRKY Another addition in the Microsoft OS.1 package is the Microsoft Editor (ME). Originally developed for internal use at Microsoft, ME is a complete, full-featured programmer's editor with versions for both real- and protected-mode operation. Capable for performing all of the operations found in popular program editors, this editor officers multifile editing, windowing, and regular expression search.

ME is extendable in C and uses an initialization file to configure the keyboard and functional setup. Sample initialization files are included to permit an easier transition to ME from popular programmer's editors like Brief and Epsilon. Several commonly used regular expressions are predefined in the editor to simplify the use

of regular expression search. I found the editor powerful but often quirky. By default the Tab key acts as a navigational key (not unlike its use in Microsoft Windows). It doesn't insert a Tab character-instead, it iumps to the next tab position. Fortunately, any default or feature you don't like can be overridden with a macro or a C extension. Although it isn't always consistent with conventional PC editors, ME fills the void caused by the dearth of protected-mode editors available at the time this review was written. Thus, with Microsoft C 5.1, Microsoft has supplied the tools necessary to make OS/2 into a highly productive development environment: you can run ME in one screen group, the compiler in another, and debug a program with protected-mode CodeView in vet another screen group.

The Microsoft C 5.1 runtime library (source code is available as an additional purchase) contains over 350 functions. Among them are the usual Unix/Xenix functions supported by a number of com-

piles, though here they are completely compatible with Microsoft's Kents version of the compiler as well. A wonderful set of graphics routines is included, as are a number of application-level functions for calling DOS services without having to meas around with interrupt 21h. The string innecions are probably the most complete and most imitated in the C compiler marketolace.

COMPATIBILITY AND SPEED Regarding ANSI compatibility, there are very few areas in which Microsoft C 5.1 docsn't conform to the emerging standard. When incompatibilities exis, most pertain to internationalization. Only a few macros and functions of the proposed standard library are not present in Microsoft C's runtime library, and a few current differences (such as a switch() accepting a long) will still comple with a warnist.

will still compile with a warming.

As for performance, Microsoft C 5.1 falls strongly in the top five (twice first or second) in execution time among the compilers benchmark tested. Like other compilers that produce considerable optimizations, compile times tend to be slow or average: you save execution time by spending more time optimizing the output code. Similarly, Microsoft C produced better execution times on benchmark tests

in which the output-code size was smaller. While features like in-line assembler, found in other compilers, are nice, one feature Microsoft Could use is a means of getting directly to the machine registers from the source code. The old Microsoft C. Int. does (1) approach is awitward and article, even though it is instanted by other compilers to the point of becoming a standard, it would be much more convenient to dead, it would be much more convenient to the confidence of the control of the control of the confidence of the control of the co

Microsoft C 5.1 is the ultimate professional compiler. It may be overwhelming to novice programmers and newcomers to C. Packed with capabilities and optomers has more features than we could possibly list. Its few minor shortcomings are outweighed by its being a consistent and comprehensive product.

—Richard Hale Shaw

PROGRAMMING TOOLS: EXPANDING THE STANDARD C LIBRARY

If you've ever used C to develop realword applications, you quickly realized that the standard libraries included with C compilers are very limited in their scope. While they include standard file and screen inputous troutiens as well as routines of general interest, they stop are short of what many programmers would like. Commercially available C libbest meager offerings. They allow programmers to add new functions to those aready found in the standard C library.

As a developer, you may wonder—why not simply write these routines yourself? Of course you understand your application better than some other programmer, who must write general-purpose routines suitable for different types of applications. For one thing, you may not be versed in every sapect of programming on the PC. If you're trying to write the next breakthrough in banking software, for instance, you may not know or care about software windowing techniques or the intraceis of video graphics. Forget about these procedures in today's pull-down menu world and your product might not sell, no matter how cleverly it balances the bottom line.

If you purchase an off-the-shelf windowing package, however, you can reap the benefits of others' programming knowledge without being distracted from your purpose.

This advantage leads to the second reason for the popularity of ready-made C libraries: it is generally much cheaper to purchase a C library than to develop the code yourself. One should never underestimate the cost of developing working, fully debugged code.

Then there's the question of timing.

No matter how good your product, it won't be successful if you can't get it out on time. Library developers often spend many months getting all the features of their packages to work in harmony. Using ready-made library packages relieves you from spending time to write the

code. The final advantage commercial libraries offer is hardware independence. particularly in the area of video displays. There's no doubt that the hardware on which your application can run will continue to evolve. Applications designed to run on the CGA workhorses of yester- . year are being pressed into service on the VGA-equipped peacocks of today. Reputable library developers have a vested interest in keeping their packages up to date with current hardware, and when the next video standard arises, these developers will quickly adapt their video libraries to support it. If your application is based on one of these libraries, generally all you have to do to bring it up to the new standard is to purchase the upgrade. make a few additions to the function calls, and recompile.

WHAT TO LOOK FOR Once you've decided to go with an off-the-shell library, keep a few considerations in mind. Most packages come with source code included, which is more of a security basket than anything else. With lack code yourself, but it's comforting to know that the source code is there. The show that the source code is there. The prisations generated with their assistance oper complete freedom to distribute applications generated with their assistance consideration worth checking.

In comparing advertising claims, you should not select a library solely on the

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number of functions it offers. Some packages include a large number of small routines, while others achieve the same results with a smaller number of generalpurpose routines. Several packages are written to support multiple operating systems, like DOS and Unix, or even different machines. This is an important consideration if you anticipate making several versions of your application available.

SOME FAVORITES Graphics and windowing packages are the most common of all commercial libraries because of their general appeal (DOS provides none of the video support that modern users demand). Longtime favorites are Power Screen from Blaise Computing and Vitamin C from Creative Programming. C-Scape from Oakland Group is laudable in its object-oriented approach to window management. The C-Worthy Interface Library from Solution Systems-of Brief editor fame-also claims to provide a ready-made user interface in its library, but the bargain offerings of smaller, newer companies like Magna Carta Software, with its C Windows Toolkit, should not be overlooked.

Databases are particularly difficult to write properly; their development should not be undertaken lightly. For any but the most trivial applications, a good database library can save the developer much frustration. Popular database libraries are ctree from Faircom and db_Vista from Raima. The latter even offers a separate SQL query support library.

Communications is another area often addressed by commercial libraries. Several companies offer popular communications libraries in the form of either simple serial routines (designed to replace the ineffective BIOS functions) or complex LAN protocol support.

Not every application lends itself to the use of off-the-shelf C function libraries. But when appropriate, their use can save the software developer precious chunks of the schedule and development budget .- Stephen Randy Davis

NDP C-386

MicroWay's \$595 NDP C-386 is not a compiler for the casual programmer. For one, it generates 386 protected-mode code with support for any of three math coprocessors (80287, 80387, and Weitek 1167). For another, its Unix 5.3 compatibility makes it more attractive as a system for porting code to and from VAX machines, or for generating intensive number-crunching code, than as a tool kit for simple PC utilities. Additionally, its software and hardware requirements place it beyond the financial grasp of the typical Ouick C or Turbo C user.

To run NDP C-386, you need 2MB of extended RAM, most of which is used for storing symbol table information and traversing the global parse tree. To execute the programs you compile, you'll need a math coprocessor on a 386 computer.

Besides the compiler, libraries, and header files, MicroWay supplies minimake and minidebug utilities. There is neither an editor nor a linker. For the former, you are left to your own devices; for the latter, you must use Phar Lap Software's 386/ASMLink 80386 Software Development Series package.

SIMILARITIES DECEIVE On the surface, the NDP C-386 package looks like any other C compiler. There are the usual



support libraries, a graphics library, and three specialized math libraries. Upon closer inspection, however, there are differences. Some, like the lack of memory modules, are moot for 32-bit compilers. Others, like the availability and location of now-common C functions, are annoving at most.

Where other packages have functions galore, NDP C-386 offers only the basics specified by K&R. This ensures compatibility with Unix-based systems, but it also means that PC-oriented programmers must write many of their own functions. In addition, many of the functions normally found in header files, such as malloc () and calloc (), are currently located in the libraries.

The minimake utility, MMC, though limited in scope, allows you to set environment parameters and what would otherwise be command-line arguments. When executed. MMC retrieves the necessary data from a database file and defaults to the last program compiled. The minidebug program is little more than a trace program, and MicroWay highly recommends purchasing Phar Lap's symbolic debugger, 386/Debug.

NDP C-386 has the ability to execute real-mode programs from protected mode (in effect enabling you to use features from other C compilers), both active and passive exception handling, and global optimization. Two of the user-controlled optimization techniques remove code from loops and weed out dead code. MicroWay suggests limiting the former optimization to key procedures and the latter to code that does not address registers (especially memory-mapped peripherals).

AVOID IN-LINE ASSEMBLY AIthough NDP C-386 supports in-line assembly. MicroWay discourages its use because of the effect on global optimization. Since the compiler rearranges storage and variable usage, in-line code (which is dependent upon its storage location) may not be able to find its variable references. Even if you take the trouble to change the location manually after the first compilation, the next optimization will change it again, thus negating your efforts.

Although NDP C-386 was primarily developed for nontraditional PC applica-

C COMPILERS

tions, MicroWay is in the process of bringing it into the mainstream. In addition to the ANSI changes, MicroWay is developing a package for designing and maintaining windows in protected mode. Besides pop-up and tilled window support, the package allows font generation and access to CGA and EGA attributes and colors.

Is NDP C-386—with all its requirements—worth the expense? If you have an application for 386 protected mode, are not afraid of writing the occasionally missing function, and you can calculate the savings from non-VAX use, the answer is a resounding yes.—Vincent Puglia

Power C

When Mix Software announced Power C at the same ridiculously low price—
\$19.95—as its Mix C, I admit that I had my reservations. I was wrong.

The inexpensive C compiler known as

Mix C had several problems, nog the least of which was performance far beyond the ability of the word "slow" to describe. It was directed primarily at the educational market, where speed was of secondary importance and price was primary. But the manual in which Mix C came packaged had such a well-written overview of the C language that I bought Mix C. kept the manual, three wavy the compiler, and still

considered it a bargain.

Power C, Version I. I, its successor, is remarkable but not perfect. The compiler's next glainty deficiency is its environment, or, more precisely, its lack thereof. In today's world of integrated editor-compiler-debuggers replete with windows and mouse-driven pull-down menus. Power C's simple prompt locks a filtel pale. And there's no order help, Fortunately, the windows and there's no order help. Fortunately, the switches to the screen. If the switches don't change, were an also save them into





consistently good performance. Power C is great for educational institutions and hobby-inst. The optional debagger is a must. Not copy protected.

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the environment and forget them.

The first pass of Power C has a few extras. There is a limited MAKE capability, and you can specify a project file as well.

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Float	0.17	0.22	52.29	51.03
*Float	32.73	37.74	52.39	51.63
Pointer	17.91	17.96	17.13	16.87
Reginter	17.79	17.91	17.14	16.64
Loop	3.90	3.90	3.90	3.90
Optimiza	0.49	0.60	8.46	8.79

"The float benchmark was re-run without optimization, due to the Zortech optimizer determining that the code was unused and removing it.

NOTE: Zortech C is included in the Zortech C++ package.

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Once Power C finishes executing the first pass, it automatically executes the second pass, the so-called optimizer, PCO. You can also entice Power C to execute the PCL link step. The combined effect is to make Power C seem to be a "one command does it all" compiler-linker.

Power C does not use the DOS linker, since Mix Software uses a proprietary circle format. Unlike its predecessor, Power C does not require a runtime environment or execute, generating instead a complete, self-contained EXE file. The compiler includes a utility for converting OBJ files generated by MASM into MIX format to allow assembly language programs to be

combined with Power C programs.
Mix Software's strong point (its manual) is still as good as ever. A short installation guide leads into a Cuttorial, followed by a C language reference good enough to keep K&R permanently on the bookshelf. The final major section is a function-bytunction description of the library, a finite protract the notion that a compiler has to a with a set of encyclopedias to be well documented.

cumented. The one problem I have with the mantual is that it attributes features to Power that the program works for controlling that the program works for controlling the memory model, but the compiler generates medium-model cutput irrespective of how these switches are set. The /Q writch is said to induce Power C to generate. OBI file output; in fact, it does nothing. While Power C documents and accepts the volatile, const, passeal, and cadea leywords, in use they have no effect. These limitations descree mention of effect. These limitations descree mention of

This is not to say that Power C does not have a reasonable claim on being 100 per-cent ANSI compatible. Enumerated data types, structure assignments, function prototyping, interrupt procedure types, register variables, VOID pointers—the vast maiority of the draft standard is there. The only ANSI features clearly raisesing are the—and 8# proprocessor tokens.

Power C implements features beyond the draft standard, including the Microsoft extensions. Mix Software claims that the Power C library is a superset of both the

Microsoft C 4.0 and the Turbo C 1.0 libraries. In addition, Power C containing the most complete set of # pragmas that I have ever seen in a compiler, thereby allowing the programmer to specify most

switches within the C program itself.

Performance with Power C is good.
Compilation speed is reasonable, with the
resulting executables turning in betterthan-average times. While not large by to-



Five easy ways to boost your BASIC

Professional Basic Programming Librar

Professional Basic
Programming Librar
Profess is a steray of 232 or
tines that ktcks BASCO
and QuickBASIC into the
and gives you powers and attitles far bayond those
mortal men. So much for t
hype, now down to bra
tacks:

600 page 3-part manual Pull-featured windowing Beream enspaces Virtual corcess in memory Lightning-part file I/O Pull mouse support as over 200 essential services or directory and equipment ultres to handy string, data, e, and input routines. For an actions of OutckBASIC and

PROREF.

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ProBas.

The TozaKir is a collection or assembly and BASIC modules the use the Pacilias library to saw you even more hours of grun work. Why spend hundreds or hours re-innesting the wheel where you can just plug in TozaKir modules like:

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Fast B-tree Indexing

Shell-sitter with word-wrap

Fatch JEXE files

Frosterid storage areas

Julian date routines

Full dock, calendar, 8CD methoroutines, and much more. Competes with EAST Gourse code and compreherative manust. The Pacific Manual Competes with EAST course code and compreherative manust. The Pacific Manual Competes with Competes with Competes with EAST course code and compreherative manust. The Pacific Manual Competes with EAST course of the Pacific Manual Competes with Manual Competes wi

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Emodans Modern 7/Emodern 1:
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plax terminal programs when can plug just the communicati routines you need into your co implement just the features, commanda you want. Requi Profiles Just \$7500.00 Our thirty day, money-by

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BBS at (\$01) 865-7736 or give
a cell at:

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CIRCLE 380 ON READER SERVICE CARD

day's standards, Power C cannot be accommodated on 360K floppy disks without disk swapping. The optional windowed source code debugger is custom matched to Power C Although I found the commands hard to remember, programmers who use Power C daily inform me that, once mastered, the debugger is a joy. It's certainly powerful enough, office every feature I could desire, and it should be considered mandatory equipment.

Overall, Power C's performance is remarkable for the price. Quite compatible with the Microsoft C and Turbo C "standards," Power C is a heavyweight contender in the educational, hobbyist, and perhaps even the professional market—at a bantamweight price.

-Stephen Randy Davis

Ouick C

Witten Comprise Quick C. Version 1.01, is many things an elegant, state-of-the-art program development environment, a furiously fast professional prototyping system, and a novie's dream complete debugger, and environment of the professional prototyping system, and environment of the professional prototyping system, and environment of the prototyping system, and featuring complete compaid billing with Microsoft C S.1 Optimizing Compiler, Quick C is designed for a wide variety of users.

vanely of users.

Although Queek C is included with Microsoff C 5.1, i.c. can be purchased at a crosoff C 5.1, i.c. can be purchased at the control of the purchase Microsoft C 5.1, voil 1 get all of the benefits of Quick C and Microsoft C combined (Microsoft C 5.1 is also reviewed here). As such, much of this review pertains to the standalone version of Quick C and will refer to Microport C 5.1 materials only when necessary. Fortunately, programs developed under Quick C can be immediately recompiled to the complex of the complex of the complex to the complex of the complex of the complex to the complex of the complex of the complex to the complex of the complex of the complex of the complex to the complex of the

The heart of Quick C is an integrated programming system, known as the Quick C Environment, that incorporates a built-in editor, compiler, and source-code debugger. It boasts true "in-RAM" compilation with options for compiling and linking to memory (unlike Borland International's Turbo C), creating an object file



When the benchmark test results for 12 C compilers were normalized against those for Microsoff C, it was clear there is no neo event leader. Offerent compilers shine in different tests. Compilers that perform well have effective operations to hardle files, strings, integer math, and floating-point emulation, those that don't perform equally well have less-

inst con i penorm equally well have lessdericent functions in these areas. In these areas in the properties of the properties of the proproduces several winners. Tutho Cs efficient file I/O operations lead to first place in the Files test, while Power Cachieves second place by performing I/O butters Valuctors. C, Version 6.S, takes their place second place by performing I/O butters Valuctors. C, Version 6.S, takes their place buttering I/O and read write operations. Nation note the smarzing across-fire-board improvement of the version-released while we were testing the compilers—over the sarties Version-

As for the execution time of stringhending operations (the String test), it's Watcom C. Version 6.5. Microsoft C, and Let's C in first, second, and third place, respectively. Fast, efficient functions called in to handle strings cause good showings on this test: Let's C, for example, has hand-coded assembler to perform string operations.

penorm string operations.

Executing the lithat heat lastest are
functionable of Microsof C, Walcom C, Version 6.5, and
Microsof C, Walcom C, Version 6.5, successful
integer math handling can depend on
several optimizations. Alforsoft C, for
variables, incrementing rather than
multiplying where possible, calculating
subexpressions and assigning them to
registers, and meeting functions right into
the code rather than relying on slower
function calls:

Finath execution times are fastest for Watcom C, Version 6.5, Turb C, and Watcom C, Version 6.0. These results reflect fast and efficient floating-point emulation code. Note that C86Pus is particularly slow on Firmath: our program does not use a math coprocessor and C86Pus on the early continued to the composition of the composition o

Turning to compile times, the best showing for each of the tests comes from DeSmer DC68, beating every other contender. DeSmer accompishes this by handling files only once, using global vanables extensively, breaking fines into tokens and then building symbol tables, and programming for speed. DeSmer is only everage to low-end, however, in execution time for the lour

programs. Second place was garnered by Turbo C, a one-pass compiler. It compiles tast and executes two of our tests among the fastest two programs, although it fartes no better than everage on two others. In third place for Files and Fmath tests is

In third place for Files and Fmath tests is Quick C, a result of its one-pass compiler, with a second pass performed for optimizations. Aztec C86 places third in the lmath test and Let's C takes third in compiling the String test.

Aztec C86 justifies its reputation for small code size, producing the most compact executable code for each of the four tests.

PC Labs compared 13 C complets using four benchmark tests. All tests used a standard 8-MFR; IBM PC 14 requiped with 30MB of hard disk storage and 64Kf of RAM, with 64K in a VIDISK RAM drive. Execution time was determined by a timing program.

Execution time was determined by a timing program. contributed with the question of the program of the second of the program of the program of the contributed of the program of the first contributed of the program of the program of the first must the decoration view program program of the program of program of the program of the program of program of the program of the program of the program of program of the program of program of program of the program of program of

Files			
Performance (Times given in seconds)	C program execution time	C compile	Executable code size (bytes)
Watcom C, Version 6.0	293.3	133.8	22,080
C86Plus	213.7	195.3	53,360
High C	177.6	37.0	40,480
ECO-C88	152.9	32.2	25,032
DeSmet DC88	143.4	6.6	25,352
Lattice C	138.1	41.2	27,952
Aztec C86	119 5	31.1	19.932
Quick C	114.1	22.2	41,990
Microsoft C	112.2	56.6	40,742
Let's C	111.8	82.3	24,816
Watcom C, Version 6.5	106.9	106.1	27,416
Power C	105.9	43.7	35,808

The Files benchmark program tests a C compler's file-handing abilities A compler's level of performance on this test results both from its ability to optimize file-handling code and from the file-handling efficiency of its

12.6 33.672

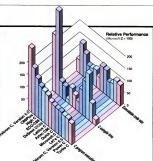
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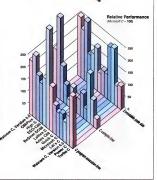
The benchmark lest works by rapidly general, closing, and reopening. The benchmark lest works by rapidly general, closing, and reopening burdens are closed to lest for the assistance of the files, and the less are remembed. The files or the microporal and variety of data disjects are written to sed read from each, Random seeks are performed beneves means to sed each from each, Random seeks are performed beneves in the control of the con

Performance (Times given in seconds)	C program execution	C compile	Executable code eize
	Sime	time	(bytes)
Wetcom C, Version 6.0	119,6	29.0	12,848
C86Plue	136.8	50.0	10.674
High C	99.5	21.9	12,992
ECO-C88	87.6	12.0	8,478
DeSmet DC88	104.6	4.4	7,406
Lattice C	217.9	13.7	9,104
Aztec C86	98.5	9.5	4,252
Quick C	64.0	10.0	5,333
Microsoft C	53.2	15.0	5,245
Let's C	57.0	7.1	, 11,616
Watcom C, Version 6.5	44.3	30.8	11,963
Power C	64.1	16.0	4,384
Turbo C	113.4	5.8	4,938

String benchmark program tests a C compiler's ability to optimize ng operations and the string-handling performance of the routines in runtime library. It attempts to use most of the string operations found

As rutinine library. It atheripm to see money in a spital of program. The sets work by installaring three character arrays and performing the operations on them. The operations performed include string operations on the programment of the performance of the pe





■ C COMPILERS

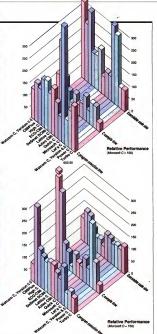
Performance (Times given in seconds)	C program execution time	C compile time	Executable code size (bytes
Watcom C, Version 6.0	102 4	13.4	11,296
C86Plus	130 8	32.6	8,404
High C	121.4	14.5	10,544
ECO-C88	_ 1604	88	4.890
DeSmet DC88	167.2	3.9	4,972
Lattice C	132.4	10.1	6,272
Aztec C86	158.5	58	2.664
Quick C	120.5	78	3,621
Microsoft C	82.0	13.1	3.54
Let's C	394.4	6.8	11,29
Watcom C, Version 6.5	88.4	12.1	10,25
Power C	128.8	11.9	3,02
Turbo C	153.4	4.8	3,06

The IMath benchmark program tests o Compler's ability to Optimize standard integer ment operations. It operates on the contents of an integer earry, performing addron, subdectson, multiplication, division, and assignment. Additionally, the contents of the arrity are occasionally sorted. The test attempts to simulate the integer math operations performed in a swinety of C program conflicts.

Performance (Times given in seconds)	C program execution time	C compile time	Code siz		
Watcom C, Version 6.0	221.9	1329	20.992		
C86Pius	961.7	65.8	28.766		
High C	463.4	21.0	27,472		
ECO-C88	410.0	15.9	18,366		
DeSmet DC88	375.6	5.2	12,806		
Lattice C	405.4	18.7	13,888		
Aztec C86	4103	13.6	10,010		
Quick C	344.2	124	22,660		
Microsoft C	301.5	22.1	- 21,788		
Let's C	483.8	15.3	18,544		
Watcom C, Version 6.5	183.1	61.1	20,296		
Power C	242.1	25.9	19,186		
Turbo C	100.0	7.0	00.764		

The FMeth benchmark program tests a C compler's ability to generate optimal floating-point meth code, based on the compler's ability to optimize libeting-point operations and the efficiency of its floating-point.

optimize librating point operations and the efficiency or its inserting point. The set would be modifying, butting, and performing betting point. The set were modifying, butting, and performing betting point and the performance of a series of arrays of blash. Standard antimited appearance such as endoine, solvation, on well-processor, and assignment are performed along with losting point operations, including the collectation of sense, coories, superior solvation. Proceedings set along the performance of the performance of the performance of the set along the performance of the performan



or an executable program.

Because approximately 150 of the runtime library routines are built into Quick C, the compiler often doesn't have to search a library to link a program compiled to memory, making in-RAM compilations very fast. And while the remaining functions are included in a disk library, it's the same rich function library that accompanies Microsoft C 5.1.

A command-line version of Quick C (QCL, EXE), also available, uses a subset of the Microsoft C 5.1 options and switches. This version of Quick C performs nearly identically to Microsoft C 5.1—with the exception that the former will generally compile much faster than latter. You can't realize the full benefit of using Quick C, however, without using the integrated environment.

INSTALLS LIKE MICROSOFT C Quick C uses an installation program that's almost identical to that of Microsoft C 5.1. The program will create the necessary directories for you (although you can supply your own overrides to the defaults), and it will not touch your AUTOEXEC.BAT or CONFIG.SYS—instead it will create

will not touch your AUTOEXEC.BAT or CONFIG.SYS—instead it will create mock-ups with recommended entries for those files. The installation program will also combine the runtime libraries for you if you choose, which will improve the speed of linkage. Although the command-line version of

Quick C supports the same five memory models found in Microsoft C 5.1, the environment supports the complaint on of medium-model programs only. Thus it has to keep only one subset of the library in memory (instead of one for each memory model) and relieves you of the need to store libraries for all the different models on your disk.

At first this library arrangement seemed an imposition, personally, I prefer to write small utilities in the small model. However, I found that when using the environment you really do need only one library, and switching between memory models is simply a waste of both time and space, not to mention being a basale. Support of in-RAM compilation requires only one memory model. When Microsoft polled its users, if found that the medium-memory model is used most offen; so this is the



model that they chose to support.

Keep in mind that Quick C does not run under OS/2 protected mode, nor does it create protected-mode applications: it's designed for real-mode applications only. Furthermore, Quick C's use is limited to true IBM PC compatibles to support its fast screen I/O.

The Quick C documentation includes a Programmer's Guide, C Language Reference Guide, and Run-Time Reference Manual. The contents of the latter two are identical to the manuals that come with Microsoft C 5.1 (purchasers of Microsoft C 5.1 receive the Quick C Programmer's Guide in addition to the standard Microsoft C 5.1 documentation).

When you buy Quick C by steef, in annuals come in softcover bindings. While they're less durable than the Microgré C 5.1 binders, they are much easier to use and contain numerous examples and figures. Coupled with the Quick C environment, they impart a relaxed, breezy feeling to the entire product—you quickly become confident that you're working with complectably designed programming tools that leave you free to concentrate your creative energies.

Of the three manuals, the Programmer's Guide is fundamental to learning and using Quick C. It contains instructions on using the Quick C environment itself: the windows, menus, keyboard conventions, and dialog boxes. There are discussions on the editor and compiler, and a section on how to use the debugger. The

error-message reference is printed on gray paper, so it's easy to find and use. An introduction to C is also included, and, while it was written for those already familiar with a programming language, it can be used by novices as well.

FOR PROS AS WELLAS NOWCES As mentioned earlier, the Quick C environment consists of an integrated system of pull-down menus for selecting, manipularing, viewing, and editing source-code flex, and for conjuging, muning, and delter, and the conjuging, muning, and delter, and the comparing, and delter, and the comparing, and delter, and the conjuging of the conjug

While the keyboard logic (Alt- and function-key combinations) is straightforward, Quick C is even easier to use with a mouse. There are options available for configuring the colors, scroll bars, and editor tab sizing. Also supported is the 43-line EGA mode. Surprisingly, there does not seem to be any way to change the editing keys, which are a combination of standard DOS editing conventions and WordStar control keys. If you're married to your program editor, you may want to stick with the command-line version, although you won't be able to take advantage of in-RAM compilations or the debugger. But before deciding anything, I'd encourage anyone to test drive the environment.

If you do use the environment and change any of the colors or options, Quick C will automatically create an initialization [ile (QC. INI) to record your changes. Quick C automatically looks for QC. INI in your current directory and in the PATH, in that order. Since you can keep multiple copies of QC. INI in separate directories, you can literally configure Quick C differently for each work area.

Besides the standard libraries, Quick C contains a fine library of graphics routines. While these same routines are available in the Microsoft C 5.1 library, the Quick C Programmer's Guide contains an excellent introduction to graphics in general, and the Quick C graphics routines in particular. Included are discussions of the various video

INTERPRETERS:

CONFRONTING THE TURBO CHALLENGE

Far from being left behind by speed-demon compilers, interpreters have kept a grip on the market by offering features not found elsewhere.

An interpreter in a first constitute to Accomplete. While a compiler conversion and entire file of source code introduced code, an interpreter dash with source code differently. Interpreters generally "lockenize" the source code; in other words, an interpreter looks at chunks of the source code with processing it and creates an internal representation of those chunks—one for each command. It then executes these tokens under the control of the interpreter is exercionates, which commands in the control of the interpreter is exercionated, which can be a command and the control of the interpreter is exercionated, which there is no control to the control of the c

Until recently compilers were portly stow behemoths, taking 5 minutes to compile, link, and test a medium-size piece of code. Therefore, using an interpreter to change the source code and then running it immediately proved a distinct advantage: change one line of code, by "mu"," and your code is processed almost instantly, with no compiler of link step. Furthermore, since interpreters included debugging capabilities, finding the provider of the second cardes a mistake show the supplementation of the second cardes a mistake show the second cardes a mistake

But there were also disadvantages to use interpreter. Code produced by some interpreters would execute as much as 1,000 times slower than would the same compiled code. And you could forget about doing real-time processing: the overhead of the interpreter's controlled environment precluded that. Yet the advantages of using an interpreter allowed code development at a price a lot of programmers were willine to pay.

THE TURBO CHALLENGE Then Borland's Turbo C compiler hit the street, wreaking havoc for interpreter manufacturers. Other inexpensive and fast compilers followed. Who would

want to use an interpreter to try out code when compiles took only seconds?

While interpreter manufacturers intially were hurt by the introduction of these fast compilers, each spotted missing features it could include, found a unique niche to occupy, and generally largeted its products more specifically.

targeted its products more specifically. Today, interpreters have a niche in three distinct markets. First is the educational market. The concept of compiling, linking, and executing a piece of code can get in the way of learning to program in C. Interpreters give the newcomer to C a single environment in which to learn a new and sometimes confusing language.

new and cometimes confusing language. Second, there are the people who have recently learned enough C to get temselves into trouble. They need an environment in which a debugger that follows a user interface similar to that of the confusion as the confusion as the confusion and the

required.
Finally, the professional developer—the experienced pro—could do well
to take a look at what some of these interto take a look at what some of these interto take a look at what some of these interto take a look at look at look at look
to take to compiler only if you're compiling frequently. With these interpreters, too
your code ideas instantly, debug them
past as quickly, and then take the debounded and optimize the best out of it.

The three interpreters discussed here

an help both the quick hack and the fullfledged project.

RUN/C Professional

The documentation for Age of Reason's RUNIC Professional is a masterpiece. The newcorner to C can take a course at the best college around, and chances are good that his textbook won't be half as good a learning tool as the RUNC Professional manual. Each function in the cone example of usage. Often, for the more complex functions, a "backgrounder" is given, with usage notes, alternate reference matterly, and a friendly approach to difficults ubject matter.

The \$149 package itself is interesting for both experienced and inexperienced users alike. Thoughtful new routines make the programmer's life a lot easier. The PREC command, for example, will display the precedence table of C operators, allowing you to circumvent the perennial memory problem of remembering the precedence of << and &&.

Typically, a developer will concertrate on a small area of code, debugging and perfecting that area before moving on to the next. RIVIC Professional gives you the capability of loading your already perfected code into a library and the using that library—at full speed! In practice, the performance penalty of funning the entire program under the interpreter forces you to adopt good programming structure.

FIAWS AND FEATS The program is not without its disappointments. First, RUNIC Professional is slow: a typical program runs about 1,000 times slower than under Turbo C. You don't buy an interpreter for its dazzling speed, but RUNIC Professional was much slower than the other two interpreters reviewed. RUNIC Professional sales has the most sewer code, size limitation.

The mysterious preprocessor is fully exploited in RUNIC Professional: you'll be able to watch it process your source file and get a firm understanding of what actually takes place.

TOOL FOR THE DEVELOPER But RUNIC Professional is also a good tool for the professional developer. Using the full Lattice C library as its starting point, RUNIC has 93 built-in functions to make a programmer's life easier. Each of these functions can be linked to the final finished product.

The ability to use certain screen functions, communications, and printer-port I/O functions, casy access to DOS's date and time functions, and a host of new preprocessor keywords make the newest release of RUNIC Professional competitive with other interpreters. It stacks up pretty well against the better compilers.

C-Terp

One of the drawbacks of using an interpreter is the interpreter's own overhead. That's where the \$298 C-Tep's ability to use virtual memory (both expanded and extended) comes to the rescue. And when you run out of this memory combination, you can use a file on-disk as real virtual memory.

Obviously, the larger the program, the more need there will be for debugging. I found the C-Terp debugger to be the easiest to use and the most powerful of the three reviewde. Apart from having the ability to use dual displays, C-Terp debug commands are more transparent and fit better into the overall environment. And C-Terp comes in a variety of "flavors," to—one for each of the more popular compiler packages.

Since C-Terp is directed toward a more sophisticated audience, it has plenty of command-line options that allow you to specify an environment more to your liking: byte alignment and nested comments, for instance. You also canhoose wheether to share commonly used (but explicitly named) structures and external namespance. Batch-mode operators

tion, a configurable editor, and the ability to configure the interpreter round out the user interface.

The speed issue isn't as serious as with RUNIC Professional, so C-Terp is more than usable, even for larger programs. And various in-line debugging commands, easily thrown into the source code, replace the ubiquitous printf() clutter found in most development code.

Instant-C

Of the three interpreters reviewed here, Rational Systems' Instant-C is the oddball of the lot, since it's an incremental compiler instead of a true interpreter.

Being the fastest interpreter reviewed isn't so bad, though. As an incremental compiler, it gives you the full speed of a real compiler, plus the added advantages of having the interpreter environment and debugger to work within. It's the best of both worlds for the experienced C programmer.

STEP-BY-STEP COMPILING Instant-C's development cycle is unique: as you "save" each function (when you exit from the configurable editor), it is compiled automatically. If a syntax error or other compile-time error is found, you'll be thrown back into the editor as close to the error as possible.

close to me error as possione.

Although Instant-C can handle up to IMB of code, it does so on a segment binsisegment basis, with each segment limied to 64K. (The library code you use is a
not considered part of the 64K.) The only
real limit is that a single function may not
coupy more than 64K, and you can have
many 64K chunks "active" at a time. So
this limitation simply forces you to follow good, modularized programming
practice.

Instant-C's manual is complete and easy to read, but not intended for the novice—the product is so comprehensive that a newcomer to C may get thoroughly confused trying to determine what he needs to know and what he doesn't.

The function library is also complete and includes some of the lesser-used functions, such as tanh() and some useful "homegrown" functions. Since a standalone .EXE file is easy to create, *Instant-C* can suffice as the only compilery ou'll need. And you can use Microsoft's or Lattice's medium- or large-

model libraries.
The Instance C interpreter is the best of the lot for the systems programmer. And Instance C's compilation speed is obligation and position in practice, however, not having to link or recompile the entire code causes Instanct C to come out a little faster. Experience C programmers would do well to consider Instance C instance C instance C with present of the control of the con



WHOLLY KAO.



orld Headou enters. Kao Geoporiston 14:10 Nhonboshi Kayabacho Fehoma, Chuo Hu, Tokyo 103 Japan, 613-669 7690 Fax 513-660-7799 Telax KAQTYO J24816 USA contact Kao Geoporiston of America Infosystems Division, 2065 Landings Drive, Mouriten View, CA 94043 (15) 965-965 Fax 14(5) 965-046 Candida Continet Keo-Grida List P.O. Dok 41, 10,1004 O hive, Anzingro, Online 1475-347 (18) 0373-3701 Fax (61) 93-3766 Sees (93-38-96) modes supported (Text, CGA, EGA, and VGA), and how to spice up applications via graphics routines. There are sections on the data sing, coordinates, plottings on the data sing, coordinates, plottings shapes and objects, and even animation. The source code for a number of graphics demonstration programs is included ordisk, as are all the examples from the Outset C Programmer's Guide.

QUICK LIBRARIES Quick C includes "Quick Libraries"—that is, libraries of functions that can be loaded when the environment is brought up and then used to supplement the built-in routines. Since you can create and customize Quick Li-

Because Quick C can produce an executable image in RAM, its speed is blindingly fast.

braries, you can take advantage of the faster compilation and linkage with your own

The debugger is a standard component of the Quick C environment. While it's primitive compared with CodeView, it is nevertheless more useful and can outperform the old and archaic technique of embedding printf() instructions in a program. The debugger includes a Watch window for viewing the contents of selected program variables as the program runs. and you can set multiple breakpoints to halt program execution on any line of the program. Once these have been set, the standard CodeView keys are available to step over or through each line of the program, observing the flow of the logic, the execution of each source line, and the changes made to variables selected in the Watch window.

Other notable features include a pragma to control pointer checking and the ability to create a Program List (a list of source files used to build a program). From this,

Quick C will automatically generate a MAKE file for building the program.

As for speed, Quick C's environment compiles and links to memory in one-half to nearly one-third of the time required by its command-line version. Because it can produce an executable image in RAM without having to read a library, its speed is bindingly fast. in addition, the PC Labs benchmark tests found that in both speed and size, code produced by Quick C scored right behind its optimizing brother, Microsoft C 5.1.

Overall, Quick C is a delight to use. Considering all of the features packed into the environment, it's a tool that professionals and novices alike will find fast, powerful, and productive.

-Richard Hale Shaw

Turbo C

In April 1987, Borland International's Turbo C was heralded as the "next generation" of C compilers. Boasting an integrated development environment with a built-in editor and compiler, it offered convenience and wildly fast compilation times

A year and a half later, Version 1.5 of Turbo C additionally features an expanded set of functions including a superb graphics library, EGA support for the environment, and general improvements to the entire \$99.95 package. While the lack of a debugger and inadequate documentation rank it behind what would be considered the state of the art in today's C compilers, Turbo C is still a powerful package with some impressive capabilities.

NSTALLAND CUSTOMIZE. Installing. Turbo C is simple—a batch file creates the your disk. It won't change AUTOSE. BAT OF CONFIG. SYS because it does not not be the control of backer files are Voc can change the backer files are Voc can change the tegrated environment) or with a text for for the command-line version. This is the kind of help Quiel C could use.

A configuration program lets you customize and modify *Turbo C*'s editing keys, as well as your video display mode



and colors. Since all the configuration options are in one place, it's very easy to set up Turbo C in any fashion. Why pay extraordinary amounts of money for a great monitor without having the ability to exploit its capabilities with a program develpment tool as furnamental as a complex? "Quantity of the property of the composition of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the comton of the complex of the complex of the complex of the comton of the complex of the complex of the complex of the comton of the complex of the complex of the complex of the comton of the complex of the co

INTEGRATED ENVIRONMENT While Turbo C includes a standard command-line version of the compiler, its real power is in its integrated environment. The

mand-line version of the compiler, is real power is in its integrated environment. The environment features pull-down menus continued to the power is the continued to the conti

A series of compiler, linker, and environment controls are available under the Options menu item. While some of these coincide with the options modified by the configuration program, others offer a great deal of flexibility at compile time. You can have the compiler warn you, for instance, about unused or unreached code, ANSI vi-

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A PREVIEW OF TURBO C 2.0 BETA

It's after midnight, a few hours from doednline, and I've just had a chance to play with a beta copy of Borland's Turbo C. Version 2.0, be latest version of the compiler that redefined C programming arine couldn't Octoures, since Version 2.0 was not in production at review dealline, PC Magraine couldn't doe a full-fledged review in its usual manner. So while you can expect to see fuller coverage in "First Locks" in an upcoming suse, here' some control of the control

While the look of Turbo C 2.0 has not changed much from that of its predecessor, you'll immediately notice a new Break/Watch menu entry, plus expanded Debug and Run menus. Suddenly you relize: At last! Integrated debugging has

come to Turbo C.

come to I sure O:

Turbo C's Debugger makes it easy to
sup or trace through a program. In funcsup or trace through a program. In funcdebugger and yo can of a breakpoint
on any line or a watehpoint on any variable or expression. You can step into or
over each function call, executing the
function and optionally tracing through
its contents. An evaluation window lets
you not only examine the contents of a
variable or the result of an expression but
also modelly the value of simple data
terms. You can stop a program from exccutation of the content of the content of a
terms. The can stop a program from exctage of the content of the content of the
A number of Geline's found in Cal-

A number of facilities found in Code-View are available in the Turbo C Debugger, including the ability to find a function's definition in the source code. A Call Stack tets you select and jump to a particular procedure call. And there are three screen-swapping options while debugging: always swap, never swap, or only swap when Turbo C has sensed that the screen is being written to. The Turbo C Debugger is available as a part of the integrated environment and as a standalone, command-line proversal.

Another big surprise is TASM, the Turbo Assembler. You won't need MASM to write in-line assembler modules in *Turbo C* anymore; Borland claims that TASM is faster than MASM and fully compatible with it, too.

As for the Turbo C 2.0 linker, it can generate COM files for thy model programs without the intermediate EXE-2BIN step. This is particularly nice, since IBM now distributes EXE2BIN, the .EXE-to-COM file utility, with the DOS Technical Reference rather than with DOS.

Borland claims that the compiler and linker are now faster than before. These claims won't be confirmed by PC Labs, however, until the production copy is available.

Improvements to Turbo C's Editor include the ability to store the edit buffer in EMS memory if it's available, saving up to 64K of main memory. In addition, some of the long-standing gripes about the Editor have been answered, introducing some features that are standard in standalone programmers' editors. Among them are optimal filling when in TAB mode, unindent to the previous indent level when backspacing at the beginning of text, and block indent/unindent.

Other improvements include an enhanced function library, command-line wildcard expansion support, improved floating-point emulation, and an .OBI file cross-reference utility. New functions added to the graphics package include installable device drivers and character forts as well as functions for generating up to 250 colors on the VGA. Finally, dual mentior support can send the control of the color of the color of the property of the color of the color of the property of the color of t

Last but not least, the documentation has been improved (see the review of Turbo C. Version 1.5, in this issue). While the functions listed in the reference manual don't begin at the top of a page, the multiple references have been reduced. A highlighted title appears in an upper corner of each page with the name of the currently referenced function.

In all, Turbo C 2.0 will be an impressive product. Although there will be other features that cannot be discussed here, Borland is already demonstrating that it intends to continue blazing new trails for C programmer productivity.

-Richard Hale Shaw

olations, and nonportable expressions. You can also force all chars to be unsigned or set the number of errors that can occur before compilation terminates.

Turbo C's graphics capabilities are nothing short of superb. It comes with graphics drivers for virtually all of the popular monitors and adapters, including Hercules, EGA, VGA, and IBM 8514. You can customize your graphics programs for a particular display adapter or design it to automatically detect the adapter at runtime.

The graphics library itself includes rou-

tines for drawing arcs, circles, polygons, ellipses, lines, bars (even 3-D bars!), and pie slices. There is a clear and logical hierarchy to these routines: you can manipulate the entire screen, a portion of it (such as a window), a specific image, or even a

single pixel.

Turbo C's considerable support for screen output lets you set the size and fonts used for text and control color at the pixel and pallette levels. In addition, you can query the state of the video graphics system by using a whole series of routines, and they return such information as assect

ratios, fill patterns, and colors. These routines are all accompanied by a detailed discussion of each section of the graphics sys-

While there is no graphics tutorial as such, I suspect that only the newcomer to C will have a problem getting rapid results from the graphics library, since a complete graphics demonstration program comes with the source code. The demo program isted is difficult to describe: "toutrageous" or "radical" come to mind. Want to have a good time? Just install Turbo C, compile the graphics demo, and run it. It is outra-

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■ C COMPILERS

geous. And since you can lift source-code examples directly from the demo program and place them in a C application, you won't need a tutorial.

EMBEDDING ASSEMBLER CODE
Another rice feature of *urbo* 6 is its ability to embed assembler code in C programs, although doing so makes the code less portable. If you're writing a function or module that requires speed or must have finet eacess to the underlying hardware, you can place assembler aimont anywhere in your program by preceding it with ass., as if it were a C-language type modifier (as for a murigard Vipp, for example).

In addition, Turbo C lets you access the

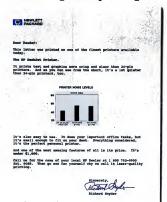
Turbo C is not without its shortcomings. One is that the program sorely lacks a debugger.

8088 machine registers directly through the use of "pseudovariables" —predefined variables that represent the registers themselves. For instance, you can produce the equivalent of the assembler operation mov ah, 1 with $_{-AH} = 1$; in your C source. This is a powerful tool for mixing or $_{-AH} = 1$; in your C and assemble without the hasse of writing functions or modules in assembler and linking them into your C programs.

Turbo C supports all of the standard memory models (small, medium, and large) and also supports the compact and buge models. Furthermore, Borland has introduced the tiny model, which limits the entire program (code, data, stack, and heap) to a maximum of 64K. This model can be used to produce programs in .COM format that are smaller and faster to run and use.

GRIPES WITH HYPES Turbo C, however, is not without its shortcomings. One is that the program sorely lacks a debugger. While there is a Debug option on the

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C TO GO: PROGRAMMING WITH A LAPTOP

There was a time when being a C programmer was like being a musician: you always had to have lots of equipment. In my bass-playing days, my gear was my livelihood and I thought nothing of having to haul a bass and a 75-pound amplifier all over Atlanta. Without that massive hardware. I couldn't berform.

Until recently, C programmens had the same problem. Running a Compare on the IBM PC was akin to riding a port in the Kentucky Derby—"if d get you some laughs, but it wasn't very productive. C compilers by their nature are big, bully, and slow in order to optimize armall, fast C programm. And as new hard ware became available, a dedicated C programmer was trint do belt or more lighted or both to gain back some of the time lost to optimize and continued to the co

But that's all changing. The latest in Compiler technology is not some new kind of optimizer. It's the Integrated Development Environment, a combined editor/compiler/debuugger, which premiered with Turbo Cover a year ago and can now be found in Quick C and Warcom Express C. With this tool, combined with additional hardware advances, C

programmers can now give serious thought to programming on the smallest (but not the least powerful) machine in the marketplace: the laptop.

There are some limitations. It's still not practical to use a large compiler, and the 770K floppy disk drives in most lap-tops are too slow for anything but in-RAM compiles. Even then they can be impractical if the source file is too blight But you can develop small programs and applications, filters, utilities, prototype and other software tools on a laptop—

when and where it suits you. Integrated environments are well suited to a laptop for two reasons. First, they require a minimum amount of disk space, since only header files, libraries, and the compiler are needed (the latter is usually smaller than a disk-based compiler, linker, and editor combined). Second, the editor, compiler, and source code are already loaded when you comnile in-RAM, so the disk is accessed only to read the header files and libraries and to write out the executable program. Thus, slow 720K disks are not a problem. Further, Quick C and Turbo C combine the compiler and linker in one pro-

use. Function descriptions are scattered

throughout-with some functions having

prototypes in one location, while their de-

scriptions are placed with a related func-

least, is good. It includes a tutorial on C

with discussions of C's elements and oper-

ators, a section designed to help Turbo

Pascal programmers make the transition to

C. and another for interfacing and integrat-

ing code written in Turbo C with Turbo

The content of the documentation, at

tion elsewhere.

Prolog.

gram, so the linker doesn't have to be loaded. And Quick C can actually create the executable program in memory, eliminating any disk accesses to link or run the program.

I ran the PC Labs C benchmark tests against the integrated environment versions of Turbo C and Quick C, using a NICC MultiSpeed. Both Quick C and Turbo C and Quick C, using a NICC MultiSpeed. Both Quick C and Turbo C and the latter performent the command-line versions, with gains from 10 percent to 50 percent. And the compile times for the integrated environments were nearly as fast on the liptop as those recorded by PC Labs on an ATI in compile-link times on the MultiSpeed with its ability to compile and link to

memory.

The combination of a laptop and a C compiler with an integrated development environment is one that simply can't be beat. No longer chained to their desks, creative C programmers can now seek out more-creative work environments. The laptop has given a whole new meaning to the concept of portable code.

Behord Hade Shavit

main environment menu, this selection is used for tracking and controlling compilation error messages.

Another gripe concerns Turbo C's documentation. A minor flaw is its use of type styles; more major is the way some of the information seems scattered between the User's Guide and the Reference Guide. A supplementary manual, added with the release of Version 1.5, includes additions to the Run-Time Library, a discussion of the new graphics routines, and enhancements to the compiler. So now you have to look in all three manuals to make sure you've found everything on a subject. While this would have been fine as an update supplement for owners of Version 1.0, packaging these three manuals together for new users is ridiculous.

And the function library portion of the Reference Guide is not particularly easy to

Where the program does not fall short is in speed: the PC Labs benchmark tests show that programs compiled by *Turbo C* are among the fastest to execute. In addition, the command-line version was the second-fastest to compile across the board, and its code size tended to be smaller on

larger on two others (files and floatingpoint math).

I found, however, little difference in the compilation speeds of *Turbo C's* environment versus that of the command-line version. And since the program always writes the executable file out to a disk, its in-RAM compilations from the environment are only slightly faster than those run from the command line.

All things considered, Turbo C is a great environment for C program development—I wouldn't hesitate to recommend it to the professional and novice alike. And while the improved documentation and the addition of a debugger would make it a superto compiler, its ease of use and speed, coupled with a wonderful graphics library, make Turbo C a powerful software development tool indeed.

—Richard Hate Shaw

Watcom C

Back in the sixties, FORTRAN was the anguage of choice among engineering students. Mastering the multiple compilation, linking, and loading steps required by the IBM mainframes of the day, bowever, was not easy. So when Watcom Group began marketing a one-step load-and-op FOR-TRAN compiler named Watfor, it was a big success.

But when double-page ads for Watcom's Watcom C appeared from nowhere last year, I was amazed. Where did these guys come from? Long forgotten by most of us who had graduated from punch cards to PCs, Watcom apparently had remained active all those years in the mainframe world. Only recently have its interests turned toward the PC with Watcom C.

S259, Macron Cheeks its mainframe heritage in many ways, starting with the docuneration. Enclosed in a convenient bookshelf box along with eight floppy disks come five sparate manuals with four quick-reference cards. (The manuals see sparate, poy our carn this and match them perspect, poy our carn that and match them many such malitvolume manuals, Watcom's are well written and easy to use. Although the installed software package godbest up 2.8MB on your hard disk, Watcom claims that operation from floppy disks is possible.

WATCOM EDITOR The Watcom C editor is a C version of Watcom's generalnumose PC and mainframe editor. While the manual doesn't entirely correspond with the editor, the differences are minor. Coming from mainframe stock, the editor fits oddly into the PC environment. For example, it can edit multiple files-as long as they all fit within 64K. The quick-reference card provides lists of bizarre Ctrl-key sequences that can be used to move the cursor, offering interesting notes like "Control-[is ignored." What about all the other Ctrl-key combinations that are also ignored? The cursor keys, fortunately, can be used instead. And the editor is screenoriented, with important function-key definitions outlined along the bottom.

Watcom C's on-line help, which includes help for the C compiler and library, is accessible only from within the editor. In use, this is very convenient. Forget printf's options in the middle of an edit? Just enter "help printf" to receive pages of information. Help with the editor communds is also firmished

The full-screen, source-level debugger has a few rough spots as well. While certainly powerful enough, complete with pull-down windows, multiple conditional breakpoints, and watchpoints, it's the little high tut try it my. Reitzing a window on the screen, for example, does not automatically resize its neighbors, instead, the action leaves an empty hand between the two windows. To its credit, the debugger comes coupleped with a powerful macro and the distribution stage and later via the function keys. This is fortunate, since the function keys. This is fortunate, since the default commands can be clumys to use.

COMPILER WITH POWER The Warcom C compiler itself is almost beyond reproach. It is powerful and implements the entire ANSI C draft standard, including such oddities as the # and ## tokens. The manual even goes so far as to note that Watcom: Group has yet to implement NOALTAS (a keyword that the ANSI com-

mittee has since dropped).

Being new in the PC market, the Watcom C library does not slavishly attempt to

mimic the PC standard Microsoft C library—it uses, for example, the Unix opendir/readdir instead of Microsoft's findfirst/findnext convention. The common extensions far, near, huge, cdecl, pascal, and fortran are supported.

Watcom C breaks new ground of its own: it uses the #pragma preprocessor di-

To its credit,
Watcom C's debugger
comes equipped with
a powerful macro
language for complete
customization.

nective to control every aspect of how asguments are passed. Vos can aspectly, for instance, that a particular function take its first argument in register AX, the second in CK-DX, the third on the stack, and the isotron in the 805°T pash-down stack. At the control in the 805°T pash-down stack, the total in interfacing with other languages, including assembly. It also let you create fast functions by replacing relatively slow DUSH and DPD instructions with faster register loads. In fact, the default for unmontas as possible in the register.

With this power, however, comes prosponshility. The programmer is obliged to include prototypes for every function, and they must be accurate, detailed, and they must be accurate, detailed, and then new ANSI format. Declaring a simple pointer to a function will nucleon accepting this and returning that. K&R format declarations do not always work either, as the manual explains. Fail to follow this, and your programs minely will not work.

When porting applications to Watcom C, you can use the clovel' keyword to force all arguments to be pushed as with other compilers; here, Watcom C is no more sensitive about prototypes than they are. The #pragma directive can also de-





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cludes Warcow Express C, Version I, Di. Requires, 312 KR AM. DOS 2, 000 falter. In Short: A hard-charging newconer in the bacyweight complier class, Warcow C 6.5 offers excellent code optimization and programmer control facilities. The product is marred only by a chumsy editor. The package includes Warcow Express C, on easy-be-use includes Warcow Express C, on easy-be-use includes war of the control of the c



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C COMPILERS

FEDITOR'S CHOICE

- Microsoft C
- · Quick C · Watcom C

If you're looking for an everythingincluded power-packed professional C compiler, you'll have a hard time choosing between Microsoft C. Version 5.1, and Watcom C, Version 6.5. Both of these optimizing compilers generate consistently fast executable code, and each packages an integrated-environment version of the compiler for prototyping and testing. You'll also find full ANSI C draft compatibility, a source-level debugger, an editor, robust libraries, and extensions for the PC environment.

Watcom C's powerful code customizations will be attractive to you if flexibility in managing generated machine code is important. Microsoft C 5.1 runs under and produces code for both the MS-DOS and OS/2 80286 protected-mode operating environment. Both represent the ultimate development tools for the professional C programmer. Among the C compilers for newcomers to C. Quick C. Version 1.01C, leads the pack with a lowcost, easy-to-use integrated development environment that includes a compiler, editor, and debugger. It offers true in-RAM compilation and linkage, and its Ouick Libraries extend the development environment. Designed for complete upward compatibility with its big brother. Microsoft C 5.1, Quick C's documentation and design give you powerful tools to grow on. A graphics library rounds it out as a complete package for the C novice.

Turbo C. Version 2.0, which was still in beta testing at the time of this review, illustrates Borland's commitment to leadership in the C compiler marketplace. We expect Turbo C 2.0, now outfitted with a debugger, a fast assembler, and an extensive graphics library, to be a strong contender in the integrated compiler marketplace that its predecessor created.

fine hex-style assembly-language macros, which are expanded in place.

Watcom has not completely forgotten the beginner. Included with the package is Watcom Express C-a combined editor, compiler, and debugger. (Watcom Express C is available separately at \$75.) In the bundled version, both programs are very similar to their standalone counterparts, but some of the advanced features, such as optimization and #pragma control, are missing. In its simplicity, the Watcom Express C debugger is actually easier to use than its more powerful brother.

What it lacks in power, Express C makes up in ease of use. You can invoke the editor and debugger separately or from within the Express C compiler. In the latter mode, you can edit, compile, and debug without leaving the Express C environment. The effect is similar to but not as polished as that of Microsoft's Quick C or Borland's Turbo C. Although Watcom C turned in some of

the longest compilation times in the PC Labs benchmark tests, it also produced some of the best program execution times. Its full ANSI implementation, #pragma directive control and excellent execution times make the limitations of the editor and debugger easier to accept. At the same time. Express C is there for those who regard ease of use as more important than power features. Watcom C is the compiler of choice for the professional and power user. And Express C makes a good starting point for the beginner. -Stephen Randy Davis

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"F

better!" That motto seems to be burned into the organic ROM of everyone in the Western Hemisphere. People buying cars and computer networks, in particular, ask, "How fast does it go?"

The answer to the question of speed is important when people are buyers. But it's trivial when they're users. Almost no one drives at 110 mph, and even fewer people pass data over a network with a throughput of 10 megabiss per second. In fact, 35 mph and 0.6 Mbps are more-typical average rate.

But the interest in speed continues. IBM effectively staked out a market segment for its as-yet-undelivered products by spreading the word that the speed of a future version of its Token-Ring Network will jump from 4 Mbos to 16 Mbos. And development of the speed of a future version of the speed of the speed

opment of a standard for 100-Mbps fiber-optic links continues. People never accepted the 1-Mbps StarLAN as sufficient for their data needs, despite its advantages in cost and convenience and the fact that it can quite easily carry the data loads of dozens of PCs in a LAN.

Between September 1987 and March 1988, a study group of the Institute of Electronic and Electrical Engineers (IEEE) discussed what standards to adopt for equipment designed to pass data at 10 Mbps over unshielded twisted-pair "telephone" wire. These proceedings saw formidable alliances of companies like AT&T, Hewlett-Packard, MICOM/InterLan, Wang, Western Digital, Ungermann-Bass, DEC, and 3Com making proposals favoring their technical solutions

The group, officially called the IDBase! Study Group of the IEEE 802.3 Standards Committee, eventually came to an interesting compromise, which accommodated two competing techniques. The group endorsed the approach championed by SynOptics and Hewlett-Packard as the basis for a new standard. It then decide that the approach backed by 3Com and DEC already meets existing standards and does not need a standard of its own.

By setting up the hardware these companies supply to make their technical approaches work, we at the Workgroup Systems Labs were able to examine their competing techniques in a way that highlights the practical differences for network buyers and users.

We found interesting differences in cost and flexibility—and little difference in performance. The 3Com, HP, and SynOptics systems each have specific connection alternatives and strengths. When we compared these twisted-pair systems with one another and with 10-Mbps coasial cable Ethernet, we found no statistically meaninful difference that the statistically meaninful difference and the statistically mean-

OF TWISTED PAIR There are three types of wiring used to connect computers together in a network: coaxial cable, twisted-pair wiring, and fiber-optic cable. Typically, the unshielded rwisted-pair wiring installed for commercial telephone systems is the most inexpensive and most

widely available option. There are many good networks designed to use unshielded twisted-pair telephone wiring. Interesting alternatives include Northern Telecom's Meridian LANStar PC (see "Making Connections: Northern Telecom's Meridian LANStar PC." PC Magazine, March 29, 1988). 10NET (see "A Field Guide to LAN Operating Systems," PC Magazine, June 14, 1988), and AT&T's StarLAN (see "Making Connections: LANs Under NetWare," PC Magazine, December 9, 1986). Standard Microsystems also has a version of the popular ARCnet networking system that runs on twisted-pair wiring (see sidebar "ARCnet's Twisted-Pair Alternative")

Of the group, StarLAN has met with the best commercial success, albeit limited. AT&T, and later Western Digital and

other companies, par a lat of resources informateding Surl AN, with disappointing marketing Surl AN, with disappointing, and easy to install. Our benchmark tests show that StarLAN delivers all the throughput that PC-based networks are likely to need. And the IEEE adopted the original StarLAN specifications at 1-Mitps subset of the 802.3 network start death Regardless, the expensive and cumdent. Regardless, the expensive and cumdent. Regardless, the expensive and cumdent. Riging increase in popularity while StarLAN stagues.

The only logical answer to this marketing puzzle is that buyers want to see higher top-end numbers on the speedometer, even if they never leave 35-mph speed zones. Buyers perceive that a low-cost 1-Mbps network system is not as desirable as a higher-cost system with higher data

3Com, SynOptics, and Hewlett-Packard all market 10-Mbps-over-twisted-pair products that appeal to this apparent need for speed. AT&T announced a whole new family of products, from faster network operating system software to its own 10-Mbps StarLAN products, which will

transmission ratings.

operating system software to its own 10-Mbps StarLAN products, which will be ready for delivery in September/October 1988. The AT&T solution will use 10-Mbps network interface cards that plug into PC- and PS/2-style computers; they will require two pairs of wire.

If moving the bits faster over twistedpair wire is the simple solution, why haven't companies done it sooner? Because the simple thing is often the most difficult to do

HARMONICS AND WIRE RUNS Every engineer is taught that the harmonics of square waves are infinite. The faster the square waves representing data move across the wire, the greater the amount of harmonic radiation they generate. Since radiated harmonics instrefer with all kinds of radio systems, the FCC strictly limits their levels.

Whereas couxial cables are able to keep radiation contained inside an outer shield and fiber-optic systems use only light, the movement of data through twisted-pair wires generates a significant amount of harmonic radiation. For this reason, the flow of data through twisted-pair wires is limited by the need to keep radiated harmonic and the need to keep the need to keep



his chart is designed to help you select from among the many information transfer and resource-sharing alternatives. As you can see on the chart, if all you really need to do is exchange tiles or share printers. then you should consider devices such as PBXs and patch boxes. If your organization has not already invested heavily in PCs or DOS programs, then a minicomputer might meet your needs more economically. But if you want many users to share data files simultaneously under DOS, a LAN may be the best alternative. Once you've decided on a LAN, the need for station-to-station resource sharing and other factors will influence your network purchasing decision

network putchasing decision.

Because manufacturers include many different features in their relevance design of the control of the control of their relevance decision of

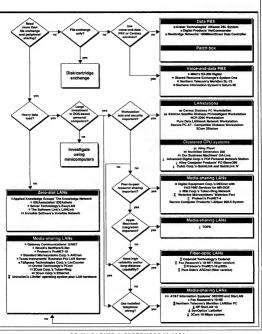
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ARCNET'S TWISTED-PAIR ALTERNATIVE

An old favorite among local area networks, when fitted for twisted-pair wiring, presents another alternative to the systems reviewed here—and keeps up with the best of them under heavy data loads.

A RCnet, a LAN media-sharing scheme, was one of the first commercially available local area networks. Enjoying a large base of installed ARCnet nodes, it also became our Editor's Choice (see "Making Connections: LANS Under NetWare." PC Magazine, December 9, 1986). ARCnet uses a to-ken-passing protocol that performs well under heavy data loads.

ARCnet is rated at a transmission speed of 2 megabits per second, but its efficient media-sharing protocol guarantees that every station gets an equal opportunity to transmit, even on a busy network. LANs using the listen-before-tails, COMA media-sharing scheme can have significantly slower throughput under a beavy load, even though their rated transmission speed is higher than ARCnet's. Typically, ARCnet uses coantial cable

(RG-62, the same used by IBM for 3270

terminal systems). But Standard Microsystems in Hauppauge, New York, the largest supplier of ARCnet hardware components, has released ARCnet cards that connect over twisted-pair telephone wire. Its ARCnet Network Controller Board retails for \$295.

Using a daisy-chain wiring topology, you can connect together small networks of up to ten stations; the wire can extend as much as 400 feet from the first station to the last. You can join two 400-foot wire segments through a 3375 two-port Twisted Pair Repeater, and you join twisted-pair segments to a traditional co-axial network using a \$375 device called a Twisted Pair I link.

The wiring alternatives for ARCnet on twisted-pair wiring lend themselves to either connecting stations economically with wire run along the baseboard or using the installed telephone wiring system and wire closets. This implementation requires only one unused pair of wires from the telephone bundle.

ON-PAR PERFORMANCE In our benchmark east, wiesto-plar ARCnet demonstrated performance under light load conditions about equal to the foliated and 1-megabit-pr-second Started LAN. When the network was looked with busy stations, however, ARCnet's orderly access scheme kept the throughput from slowing down like Starten LAN's—under load, wisted-pair SARCnet performed on a par with the 10-Mbps twisted-pair systems.

Because of various marketing and business considerations, ARCnet does not conform to any IEEE standard. But it is a widely used networking scheme with good performance and a twisted-pair wiring option.—Frank J. Derfler. Jr.

monics at or below acceptable levels.

Engineers use several approaches to get acceptable 10-Mbps transmission over twisted-pair wires. The most complex solution, from Hewlett-Packard, involves a modification of the square wave form to reduce harmonics. 3Com uses a technically simpler scheme that accepts shorter transmission distances.

While the IEEE discusses standards for signaling over twisted-pair wiring, the Electronic Industries Association (EIA) is working on standards to describe how the wire about be run. After the breakup of the bell Telephone System by a U.S. and the bell Telephone System by a U.S. and the bell Telephone System by a U.S. and produced the standard of the control of the Northern Telecorn developed their own practices for installing telephone wiring. And each company published its own descriptions for the maximum length of wire runs, the types of connections, and other trains and proportionalishings that the EIA is

trying to correct by establishing a new standard.

Although the committee's proposals haven't been published, it's likely it will recommend a maximum length of 100 meters for any single wire run. While 100 meters (228 feet) doesn't seem to be a very long distance, the companies involved in this process, particularly AT&T, haves-perience and studies showing that nearly all types of workgroup systems do indeed fit into this writime plain.

The HP twisted-pair network scheme can easily exceed the 100-meter distance; the maximum run for the HP StarLAN 10 is 250 meters, the equivalent of 820 feet. In an ideal wiring installation, the 3Com system should easily reach 100 meters, but to buildings with less than ideal wring plans, the operational distance drops quickly. The Symophics system is rated for wire runs of just over 100 meters in typical installations. MIX TO MATCH MEDIA Twisted-pairwiring systems typically use a physical hub topology, with all wires running to a hub in a central wiring closet. The wiring closet usually houses voice telephone cuujument and is also where the wire pairs

carrying voice and data in the same cable split apart.

The hub topology takes more wire than a station-to-station wiring scheme, but each node has its own dedicated cable run to the hub. The result: if one cable run is broken or shorted, the failure doesn't bring down the whole network as it does in a station-to-station system.

This hub also serves as a point for bridging together different types of wiring. Joining several types of physical links lets you use the best wiring alternative to reach each network node; you can mix and match media within a network to meet the needs of each link.

The high-speed connection schemes

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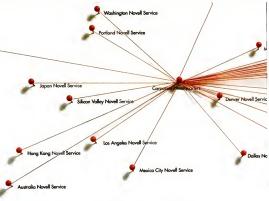
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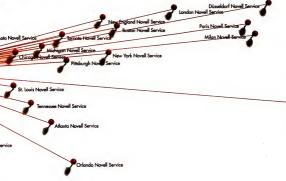
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■ TWISTED-PAIR LANS



Our benchmark tests on helsted pair wring LAN systems clearly show three things. In:th. the statistically insignificant differences between the 10-Mbps, helsted pair and the coasial systems proved the 10-Mbps helsted pair and the coasial systems proved on the 10-Mbps systems show that the systems are added to the 10-Mbps systems show that the systems are not even close to being buty sittles. And finally, the differences in performance between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps systems and a standard 1-Mbps 147-Standard between the 10-Mbps 147-Standard between the 10-Mb

All of these benchmark tests were run under Novell's Advanced NetWare, Version 2.0a, with 8.4Mr2 IBM PC AT as a workstations and the server. The tests of the 3Com and SynOptics systems were run using 3Com network interface cards in all workstations. The test of the Hewlett-Packard Start.AN 10 was run using HP network interface cards in the client stations and a 3Com 3C505.

card in the AT server connected through an HP MAU in the server. Of the two systems shown for comparison purposes, the EtherLink connection uses 3Com EtherLink cards and a coaxial connection in an EtherLink dails' chain topology. The Start.AM 1 connection uses Western Digital Start.AM cards operating in a hub configuration that resembles the 10-Mbps twisted-pair systems.

The Memorit Signed Under Load and the Neet Disk. Access Load Bordonia Intelligence (1997) and Access Load Bordonia Intelligence (1997) and Intelligenc

This Network Speed Under Load test puts a heavy load on the rehator's interface (cards, media, and to loft) which cards are the second of the second of the second of the station continuately read and with its own 1-5 year data file, changing the data each time. For systems with data, caching, the load on the hard data, is even smaller, since caching systems typically perform a disk write but do not negative a physicial data read.

The Hand Disk Access Load test heavily loads the hard disk and disk-caching system. To do the, each station sundown, accesses its own 100K data file using 1K records. Data written to the file is changed each time. The random reads typically access data outside the cache, which forces a disk read, as does any write.

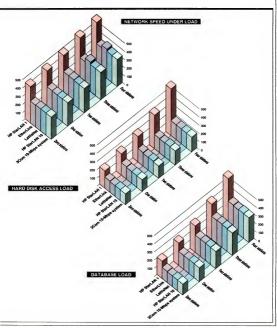
The Database Load test carriers the system's recordbiologis apport and the way it haudes a number of smooth missilaneous accesses be a common file. The selement has filed and budge glother accesses a common accesses are single-searches filed filed filed and accesses accesses are single-searches filed filed filed filed accesses are single-searches filed filed filed filed for accesses and accesses and accesses and accesses also both the data record and update the contents. The money of the content of the contents of the contents of the OGS 3 I BLOCK platement prevents smultaneous robot the update.

Performance Times (Times given in seconds)	Zero	One	Two	Three	Four
System	stations	station	stations	stations	stations
HP StarLAN 1	439	468	498	551	579
EtherLink	264	280	301	310	322
LattisNet	268	278	301	356	353
HP StarLAN 10	269	280	296	327	329
3Com 10-Mbps system*	270	283	296	329	327

HARD DISK ACCES	SLOAD				
Performance Times (Times given in seconds) System	Zero stations	One station	Two	Three stations	Four
HP StarLAN 1	209	257	307	406	566
EtherLink	136	150	162	174	182
LuttisNet	130	142	154	168	181
HP StarLAN 10	132	143	158	175	180
3Com 10-Mops system*	131	142	149	171	179

Performance Times					
System	Zero stations	One	Two stations	Three stations	Four
HP StarLAN 1	209	272	322	426	576
EtherLink	136	169	212	280	305
LattisNet	130	170	212	284	297
HP StarLAN 10	132	172	211	282	305
3Com 10-Mbos system*	131	170	208	275	302

"LanScanner, MultiConnect Repeater, and PairTamer



m TWISTED-PAIR LANS

In the 3Com and SynOptics systems, the connections to the different media are made by inserting hardware modules containing the appropriate electronics and connectors into the hub. The HP system uses a simpler connector setup with only a little less flexibility.

Separate connection modules let you incurrentally expand and modify the retwork wining plan. You can mix fiber, co-axid, and wisked pair modules in the same hab for the best performance. The sole drawback is that the hab and modules, containing power supplies and other electronic components, are expensive. Thus far the network market has shown a remarkable insensitivity to price-amarkable insensitivity to price-accoment in the long run.

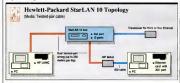
HEWLETT-PACKARD CO. HP StarLAN 10

The acronym MAU has two definitions in the taxonomy of networks. IBM defines an MAU in its Token-Ring system as a Multistation Access Unit, a central hub that has cable running to each network node or to other MAUs. However, the more common definition of an MAU, as used by Hewkett-Packard in its Start.An 10 system, is a Medium Attachment Unit. The HP MAU is a very different product from IBM's hub.

The HP MAU has a pigtail connector for an Ethernet transceiver cable on one end and a modular jack for twisted-pair wiring on the other. This box converts between the standard Ethernet link and a run of two twisted-pair wires. While a single MAU selfs for \$295, in some installations you need row MAIS per Hirk. In other



HP's StarLAN (0 ystem includes the StarLAN to that left, rear view), the LAN interfore card (LANC), and the Media Introheme unit (MAU). The LANC can attach drivet to the that to rea an MAU over two twisted-pair wires. The MAU attaches to a sumdand network interface card, or other device, through a 13-pin AU part n. A Spip in connection on the back of the hat manuts either the 12-port twisted-pair connector, as shown here, or a cable used to make connections to a the cliebonow-wire that the connections to a



types of installations, the device at the other end of the link has its own twisted-pair connections.

The twisted-pair MAU takes power from its attached node and actually repeats and regenerates the signals. The HP system doesn't allow a style of nodes to take

advantage of the services of a single pair of MAUs, as does the 3Com 10-Mbps system. But you don't have to use a twisted-pair MAU to connect a PC to the network over 10-Mbps twisted-pair wire, as you do with the 3Com system. HP markets network interface cards to do the feb. as well.

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THE LANIC ALTERNATIVE Digital Equipment Corp. leads the world in the use of acronyms (all beginning with D), but Hewlett-Packard does pretty well in the acronym game, too. It took me 5 minutes to translate the acronym LANIC used in the HP manual into LAN interface card

The HP LANIC for StarLAN 10 lets you connect 10-Mbps services to twisted-pair wiring, so you don't have to use a separate MAU. HP bundles a LANIC with its OfficeShare software and sells the package (called PC Link) for \$695

The HP LANIC is a circuit board with an RJ-45 connection for the twisted-pair cable and an RJ-11 connection for a telephone. The separate telephone connection is common in Start.AN cards; it lets you conveniently integrate telephone and data wire pairs in the same cable. Data and voice signals can ride over different wires in the same cable to the wiring closet, where they then go their separate ways.

where they then go their separate ways.
You can set DIP switches on the
LANIC for I/O base address, DMA (direct
memory access) channel, interrupt channel, and loopback test mode. The loopback test is useful for testing the card without disturbing or relying on the network.

Interestingly, to networking software the HP LANIC looks like a 3Com 3C501 network interface card. This is useful because the 3C501 is well supported by various network operating system vendors.



■ While Hewlett-Packard's StarLAN 10 hub lacks some of the

slide-in electronic elegance of the 3Com and SynOptics systems, it's simple to connect and use.

You can generate a standard 3Corn workstation shell using Novell's NerWare, or another LAN operating system, and plug in the HP card. Overall, the HP LANIC makes the 10-Mbps StarLAN as easy to install as the 1-Mbps version.

STARLAN 10 HUB HP's \$2,995 Star-LAN 10 hub, which can service up to 12 network nodes plus a link to another hub, is configured very differently from the 3Com and the SynOptics devices. Instead of using electronic modules, the HP hub has two versatile connectors that you can use for a variety of purposes.

A 15-pin connector on the hub, called the Attachment Unit Interface, or AUI, connects either to the HP MAU for a twisted-pair link or to an appropriate transceiver for thick Ethernet, thin Ethernet, or fiberoutic cable.

A separate SO-pin connector attaches to a 12-port modular adapter for connection to 12 HP LANICS or MAUS. Optionally, you can design a different arrangement for the SO-pin connection using a 50-wire cabe farmed out to a telephone cross-connect block. These blocks (also called "punch-down blocks") provide a handy way of intervonnecting multiple wire runs carrying voice or data from several locations.

While HP's StarLAN 10 hub lacks some of the technical elegance of the slidein electronic modules used in the 3Com and SynOptics systems, it's simple to connect and use. The only drawback to its design is that it can't interconnect twistedpair wiring with more than one other type

of cabling: you can have twisted-pair plus thin coaxial, thick coaxial, or fiber-optic cable—but not all three together. The designs of the 3Com and SynCoptics units let you mix all the media. Frankly, though, this isn't a serious limitation since there aren't many installations that mix more than two types of media.

man two types or nectus.

The HF StarLAN I0 system is not inexpensive (at a minimum, the cost of this sysem is over \$200 per port), but it should be a winner. It has the speed that buyers seem corpianal StarLAN design. The StarLAN IO to be supported by the starLAN in the starLAN IO had doesn't offer you as wide a choice of nodia as the \$200 mr SynOpiois implementations, but it offers enough alternatives for almost all installations.

SYNOPTICS LattisNet

Because SynOptics' LattisNet has been shipping longer than the other two products reviewed here, it has the largest installed base and has gained more third-party support.

SynOptics calls the system LattisNet, but not all LattisNet products come from SynOptics. Two other network products



329 N. Bernardo Ave. Mountain View, CA 94043-5223 (415) 960-1100 List Price: Model 1010 Department Concentrator, \$2,100; Module 405 connection module (up to three in each 1010), \$1,900; Model 1201D Diagnostic Module (one per 1010), \$125; Model 2500 Work Group Concentra tor, \$2,800; Model 2510 Retiming Concentrator, \$3,000, Model 505 unshielded twisted-pair transceiver, \$155; MICOM/Inter-LAN NI5210 LattisNet interface card, \$495. In Short: The SynOptics LattisNet system provides good flexibility in a 10-megabit-persecond twisted-pair system. You can configure the various models of LattisNet Concentrators to match your network arch

Third-party vendors such as MICOM-

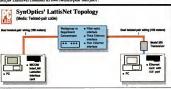
LattisNet architecture. CRCLE 600 ON READER SERVICE CARD

InterLAN supply products supporting the

■ TWISTED-PAIR LANS



The pieces of the Lattisket system shown here are the Model 2510 Retiming Concentrator (SynOptics' newest concentrator), the SynOptics Model 505 Transceiver, and the MICOM/Ilner LAN Model NDS-210 network interface card. The transceiver is used with existing Ethernet/IEEE 802.3 network interface cards and other devices with 15-pin AUI ports. The MICOM/IlnerIAN card for Lattisket contains its own visuset-poin interface.



companies, MICOM/InterLAN and Kinetics, market network interface cards for LattisNet that allow computers to connect directly to the 10-Mbps twisted-pair wiring without going through a transceiver. The MICOM/InterLAN card is for the PC, and the Kinetics card fits into the Macinthe three systems under review, only LattisNet provides direct connections to Apple Macintosh products.

ing without going through a transceiver.

The MICOM/InterLAN card is for the PC, and the Kinetics card fits into the Macintosh SE and Macintosh II computers. Of size of a parerback book. The \$155 Model

505 transceiver has a 15-pin AUI plug to connect with a standard Ehrente, or IEEE 802.3, network interface card or other devices on one can and a modular connector for two rwisted-pair wires on the other. It takes its power from the AUI connection with the network interface card and regenerates the signals passing to and from the dual twisted-pairs. A green status IEED on the transceiver shows that the link between

■ The LattisNet system offers a proven technology with growing third-party support. It has the greatest choice of architectures of the products reviewed.

the network interface card and the transceiver is good.

The only tricky part about installing the Model 50st ransceiver is ensuring that you have a cable with 15-pin connectors on both ends to go between the interface card and the transceiver. The similar HP device has an attached pigual cable; the 3Com Parl'amer uses thin coaxid cable. The cable between the Transceiver and the interface card can be up to 50 feet but pot 50 feet but 50.

The other end of the dual twisted-pair wining links to the lab in the wining closet. SynOptics calls its wiring habs concentrators, and it markets several kinds for different network sizes. At \$2,200, the Model \$200 Work (from) Concentrator is the least-expensive unit. It provides up to eight marketed without pair uplink for connections and one twisted-pair uplink for connections and one twisted-pair uplink for connections and one by Concentration in a small network, or as the local hub for a cluster of network stations in a larger system.

Another concentrator, the Model 1010 Department Concentrator, is a flexible device able to connect up to 27 nodes or to act as a master concentrator for other sub-

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TWISTED-PAIR LANS

networks. Interface modules in the concentrator connect directly to the twistedpair coming from the Model 505 transceiver. Other module types make thin coaxial, thick coaxial, and fiber-optic cable connections.

If you want to connect the twisted-pair wires directly to the network interface card. MICOM/InterLAN sells a \$495 LattisNet card. MICOM/InterLAN is a leader in providing products using the TCP/IP network protocols, and its network interface cards have a lot of flexibility.

The LattisNet system offers a proven technology with growing third-party support. It has the greatest choice of installation options and architectures of the products reviewed here. Although the components are costly, careful design can keep the price per node to a level comparable with the HP Starl AN 10

3COM CORP. **PairTamer**

MultiConnect Repeater LanScanner

Although 3Com's 10-Mbps twisted-pair plan begins with the company's standard network interface cards, its implementation is external to the interface cards. You don't have to use 3Com's network interface cards with 3Com's twisted-pair equipment-the twisted-pair setup will work with any Ethernet system using thin coaxial cable, as well.

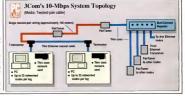
The coaxial connection on the interface card (or eards in a station-to-station wiring scheme) is attached through thin coaxial cable to a device called a PairTamer. A PairTamer is a small box, about the size of a cassette tape, with a coaxial connector for thin Ethernet coaxial cable and a modular connector for twisted-pair wire.

PairTamers connect together over a single twisted-pair wire instead of the two twisted-pair wires used by the majority of twisted-pair systems. Using a single twisted-pair wire is an advantage when you share cables with voice telephone PBX (private branch exchange) systems, which often require two or three wire pairs for voice telephone services.

Since the PairTamer is not powered, it doesn't repeat or regenerate signals, it only



3Com's approach to providing 10-megabit-per-second service over twisted-pair wiring includes three separate products: the PairTamer, the MultiConnect Repeater, and the LanScanner. Two PairTamers (lower right) connect between thin Ethernet coaxial cable and a single twisted-pair wire: PairTamers connect at any point in the Ethernet cable. The MultiConnect Repeater (top) accepts several electronic modules equipped with interfaces for different wiring schemes. The LanScanner (lower left) is a portable diagnostic tool that analyzes important characteristics of twisted-pair and thin Ethernet cabling systems.





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■ TWISTED-PAIR LANS

transfers them between coaxial cable and twisted-pair wiring. Since a PairTamer is needed at each and of the twisted-pair wire to convert between the coaxial cable connection and the twisted-pair wire, they are sold in sets of two, at \$150 per pair. This type of device is called a balan, short for balanced-to-unbalanced transformer. (A different type of balun transformer is often used to match a coaxial television cable to

■ The 3Com LanScanner, a portable measuring device, doesn't take all the work out of surveying twisted-pair wiring, but it does take out the guesswork.

the twin lead connection on a television

set.) You can use PairTamers to replace coaxial cable with twisted-pair wire anyplace in the network. For example, you can string together as many as 25 network nodes in a traditional EtherLink station-tostation wiring scheme over coaxial cable, with one PairTamer to extend the network over twisted-pair wire to reach another node or group of nodes. Although it's possible to implement a station-to-station wiring scheme using PairTamers, buildings typically aren't wired that way. Twistedpair wiring usually runs from a desktop to a central wiring closet, not from desktop to deskton.

IN THE CLOSET The MultiConnect Repeater is the bulb attice severything together in the wiring closet. The basic elsewing of the ment of the MultiConnect Repeater is a
cabinet containing the power supply, some electronic components, and an expansion on
bus that is designed to accept transcriver
modules for several different types of cabling. The MultiConnect Repeater carries
a retail price of \$1.095.

You can insert transceiver modules, averaging about \$200 each, into the Multi-Connect Repeater for thick or thin Ethernet coaxial connections; other vendors will soon supply modules for fiber-optic links (see "Making Connections: The Who, Why, and How of Fiber-optic LANs," PC Magazine, January 12, 1988.

Magazine, January 12, 1988), MultiConnect Repeater transcriver modules are not available for twisted-pair wire. If, you want to connect to the MultiConnect Repeater using twistedpair wiring, you must use on external Tamer and a Repeater Module for thin cotains and the control of the control of the control of the control of you characteristics. The control of you characteristics when a separate twistedpair module in the MultiConnect Reput would do the job with less clutter and presumably less cost.

The status and activity on each link, indicated by an LED that is located on the transceiver module, is monitored by the MultiConnect Repeater. Links that cause network errors are isolated by the Multi-Connect Repeater, and you can manually disable them with a switch on the transcriver module.

You don't have to use a MultiConnect Repeater with a PairTamer—they are sep-







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AMOXOS

TWISTED-PAIR LANS

arate products. But the typical wiring plan of a building brings twisted-pair wires together in a wiring closet, and the Multi-Connect Repeater connects the links, regardless of the type of media they use.

EVALUATING THE LINKS Specific runs of twisted-pair wiring can vary widely in their resistance and other electrical characteristics: few buildings more than 5 years old were wired with data transmission in mind. And before you can count on existing wiring for network connections, you often need to have an expensive survey of the existing wiring. 3Com gives you a way to check out coaxial and twisted-pair wiring that is useful to anyone who is planning on using twisted-pair wires, even if you aren't using 3Com's network products.

The 3Com LanScanner, a portable hand-held device, measures the resistance, ambient electrical noise, and other electri The three 3Com twisted-pair products provide a network planner with a useful mix of media.

cal characteristics on twisted-pair and small-diameter coaxial cable. Powered by rechargeable nickel-cadmium batteries, it sells for \$995 and for most purposes gives results as useful as devices costing ten times more

The LanScanner doesn't take all of the work out of surveying twisted-pair wiring, but it does take out the guesswork. Its re-

sults aren't as precise as those gained from using a \$10,000 oscilloscope equipped for time-domain reflectometry, but they are certainly good enough for practical instal-

You can check any type of coaxial cable for opens and shorts, including the cables used for ARCnet and IBM 3270 connections. The LanScanner tells you how many feet down the cable an open connection is, making it easy to troubleshoot connector problems. You can test the loop resistance of the twisted-pair wire to ensure that the signals will get to the other end. Then you can measure the noise on the line to see what the signals will contend with

when they get there. All of this is done from the two-line LCD that you can see on the top of the LanScanner, which has the feel and heft of

a large paperback book. Four cursor keys let you select the programmed functions from the display.

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■ TWISTED-PAIR LANS



· 3Com's 10-Mbps system

SynOptics' LattisNet coats more but is elegantly designed and has some very nice features. Hewlett-Packard's StarLAN 10 is sensibly engineered, flexible, capable, and reliable. 3C om's 10-megabit-persecond wisted-pair system works great anywhere, and it doesn't cost a lot.

These are all top-grade products that are competing for attention in the comment of the comment

Regardless of what brand or type of network interface cards you use, if your network runs on twisted-pair or thin coaxial cable, you will find the LanScanner to be an extremely useful and economical tool for cable installation and system maintenance activities.

THE SUM TOTAL. The three 3Com visited pair products—PairTamer, Multi-Connect Repeater, and LanGeaner—are speated evices that work well abone or to-gether. The PairTamer is an economical way to attach nodes to a network over a single twisted-pair wire. The PairTamer and LanGeaner are useful in many darad LanGeaner are useful in many darad and and canner are useful in many the state of the stat

Frank J. Derfler, Jr., is workgroup systems editor of PC Magazine.

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Until recently, refusing to play by the rules that fixed disks dictated probably meant buying a Bernoulli Box II, Iomega's 20MB removable-cartridge system. Also available under Tandy and Mountain Computer labels, the Bernoulli Box has gained a substantial and near-fanatical following for its dependability and crash-roof removable cartridges.

Now, as more and more users discover the advantages of removable mass storage, an explosion of new products has emerged to challenge the traditional leader lomega for control of the growing market.

The products are as varied as the applications and data they hold. Some challenge Iomega on its own terms, with durable but slow flexible-disk designs. Others, from major players like Plus Development Corp. and Tandon, go for speed and capacity with portable, self-contained Winchester drives. Still others fit the plated, rigid media of hard disks into a removable cartridge, separate from the read/write head.

While each of the 13 systems we tested has advantages in common over conventional fixed disks—namely, portability and unlimited storage capacity—no one product proved superior for every application. Rather, each offers distinct advantages for some applications and suffers formidable limitations in others.

FLEXIBLE-CARTRIDGE SYSTEMS
The data-gray media at the heart of the alltoo learning in opposite is not ready as capagray side and the part of the alltoo learning in opposite where meanings in
gray good and the part of the allgray good and the part of the allgray systems toward hard disk capacity—up to
20MB—Som floopy disk media by adding more-legalur mechanisms and incorporating servo-controlled head positioning. Simply put, they give the headpositioning mechanism the precision it needs for and and with edia more densily media for the concelled in read and with the dia more densily.

The disks themselves are enclosed in plastic cases—at least in part to keep debris away from the disk surface—but the disks remain mercifully small and light.

One advantage of a flexible-cartridge system is its ability to take a beating. At worst, dropping a removable flexible cartridge will mean cracking the cartridge case, a mishap that would most likely leave the disk readable.

Flexible-cartridge systems also offer the most cost-effective removable-mass-storage solution if your application requires more than a disk or two per drive. Though the cost of the drives is far from trivial—\$800 for the least expensive system reviewed here—the cartridges themselves typically sell for under \$100.

Unfortunately, the technology that makes these systems durable and inexpen-

sive also makes them slow and susceptible to media wear. Like floppy disk drives, all but one of the systems we tested—the Bernoulli Box II—operate with the read/write heads touching the media surface. The Bernoulli Box II rides the heads about a millionth of an inch off the disk surface, high enough to reduce wear but not high enough to eliminate it.

To keep the wear on the soft media to a minimum, the systems spin the disk at a fraction of the 3,600-revolutions-per-minute rate of hard-disk platters. Eastman Kodak's Verbatim 12MB Internal Subsystems, for example, spins a disk at only 600 rpm. The Bernoulli Box's floating-head

■ One advantage of a flexible-cartridge system is that it can take a beating. At worst, dropping it will mean cracking the case.

design allows it a speed of about 1,800 rpm. Though necessary to combat media wear, the slower rotation severely limits disk performance, since the heads can read the data only as fast as the disk can move it past them.

REMOVABLE HARD DISKS The events and toxole breed of removable mass storage—emovable hard disks—bouse. Windrester drives in seal unit designed for portability. You get the same hard disk technology your system has now, but in a disk drive you can remove in seconds. The field includes products from newcomen like Tradewinks Peripherals and Western-Dyrex Corp., as well as seasoned players like Plus Development Corp. and Tradom Corp.

The Winchester technology makes these products attractive in the areas where the flexible cartridges get poor marks: speed, media life, and capacity per unit. But that same technology suffers serious shortcomings under circumstances that show flexible cartridges at their best.

As with all Winchester cystems, the read/write heads ride on a cushion of air above the surface of the rigid disk platters. Since the heads down tooks the platter such that the platter surfaces are tougher than those of flexible media, the disks roatest a vigcours 3,600 pm with no significant wear. The rigidity of these platters allows two or more to be packed closely together in one drive, yielding capacities higher than flexible cartifidees can offer.

One of the problems with Winchester drives is their fragile nature. They fare well when sitting in a stationary machine on a desktop, but the read/write heads, the platter bearings, and the platter surfaces themselves can easily be damaged if a disk is

dropped. To combat the problem of fragility, each of the products that we tested boasts some level of shock protection in sinch-mounted assemblies. Plus Development? Passport carries a manufacture-assigned shock rating of 150g (acceleration of gravity) and was able to withstand drops of over a foot onto a hard surface. Tandon's Ad Pac boasts a rating of 300g and survived even a casual toss over the shoulder of one of our reviews.

With each substantial drop, however, a removable hard disk will suffer at least some bearing damage and will move closer to complete failure. No matter how good the shock mounting, Winchester drives are simply too fragile to take a regular beating.

Another problem with Winchester drives is the potential for the read/write heads to plow into the media surface. As long as the disks spin at their proper rate, the motion sustains the cushion of air that

OUR REVIEWERS

Mitt Jones is a senior editor of PC Magazine. Stephanie K. Losee is an assistant editor of PC Magazine. Bill O'Brien is a project leader for PC Labs.

Jennifer Zaino is an assistant editor of PC Magazine. holds the heads away from the platters. If the system loses power unexpectedly, or if you turn off your system without parking the disk heads, the lack of cushion can send the heads crashing onto the platter surfaces, thereby damaging the platter surfaces, the read/write heads, or both.

To climinate this problem, some manufacturers offer automatic head parking, or auto-parking, in hard-disk parlance, Ideally, auto-parking means that the heads automatically move to a nondata area of the platters, even in the event of sudden power loss. In practice, auto-parking often indicates a less-than-ideal substitution.

cacks a resecutam-near substitution. For instance, the Plato Hardpace 20, from Artistotle Industries, offens only a formation of the Plato Hardpace 20, from Plato Hardpace 20

The potential for head or disk damage is even greater with removable hard disks, since the heads can also bounce around on the surface of the platters when the disks are being transported. You'll want a system not only with auto-parking but also with bead-locking. Plus Development's Passport and ProStor's TransPac are the only systems reviewed here that include true automatic park and lock: Tandon's Ad Pac runs a close second. It automatically parks and locks its heads before it ejects the hard disk from its recentacle, but the heads will fall to the disk surface if the disk unit is still in its receptacle when you cut power to the system.

The initial cost of a removable hard disk system is about the same as that of a flexible-cartridge drive. But expanding storage with additional hard disk units drives the cost of these systems much higher than that of flexible-cartridge systems. For instance, Tandon's 30MB disks—among the least expensive of the removable disks tested—retail for \$399; a 20MB Bermoulli cartridge lists at \$33.

REMOVABLE HARD CARTRIDGES
The final category of removable mass storage—removable hard cartridges—also
makes use of Winchester technology but

separates the read/write mechanism from the disk platter. The platter rests in its own removable cartridge.

The idea, of course, is to combine the performance of Winchester drives with the convenience and low replacement cost of removable cartridges.

For the most part, the idea works. The SyQuest SQSSS earned impressive times on PC Labs benchmark tests, beating out most of its Winchester coustins hands down. Unfortunately, the system includes no provisions for auto-parking, and the cartridges themselves—more fragile than their flexible counterparts—seem incapable of sustaining severe drops.

Sysgen's internal and external DuraPak didn't fare as well as the SQ555 during speed tests, but the DuraPak does include auto-parking. The DuraPak cartridges also seemed more capable of taking a drop than did the SQ555 cartridges, though they can't compete with flexible cartridges for

all-around durability.

Another problem with this design is its vulnerability to damage from tiny particles that can cause diseaster in a Winchester environment. Most Winchester drives seal the platters and read write mechanism into one chamber to keep out contaminants of the platters and read write mechanism into one chamber to keep out contaminants on the control of the platters and read with the platters and read the platters are sufficiently to the control of the platters are sufficiently to the it is investigated and that platter surfaces. While dust may not cause serious data loss, or any data loss at all, it undoubtedly shortents the media list?

PROSAND CONS If you can remove it, sooner or later you'll drop it. You'll want a product built for rugged duty even if the longest trip your disk makes is into the company safe each night.

Though g ratings can sometimes be misleading, our experience has shown a fairly consistent correlation between the manufacturer's rating and the ability of the product to take a fall. Where possible, we have tested the durability of products and have reported our findings in the separate product reviews.

Without exception, however, flexible cartridges take a beating better than does the competition, making them the wisest choice for sending disks across the country

via express mail, or even across town via Sneaker Net.

For other applications, the choice is less clear. Removable-cartridge systems offer the most cost-effective means of providing unlimited capacity or segregating projects onto different disks, but the more-expensive removable hard disk systems provide a tempting blend of performance, per-unit capacity, and media life.

Several of the products offer features that may suit your specific needs. For instance, both the Bemoulli Box III and Plus Development's Passport offer installation kits or IBM's MCA PS/2 models—a boon if you're struggling to port data to the PS/2.

models.

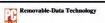
Another important point to keep in mind when perusing the reviews is to fine configuration of your system. Doc's cludes device drivers for only two physical hard disks. I you'll want a disks substyate that includes its own off with two separate hard disks. I you'll want a disk subsystem that includes its own functions in the configuration of the configura

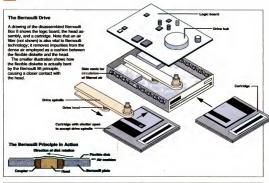
FLEXIBLE CARTRIDGE SYSTEMS

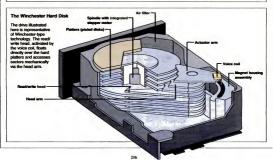
EASTMAN KODAK CO. Verbatim 12MB Internal Subsystem

When is a removable hard disk really a removable hard disk? That seems to be a simple question, but one for which there is a simple question, but one for which there is a simple question, but one for which there is a simple question. It was a simple question and the same and th

Eastman Kodak has been a developer of high-density floppy disk drives for quite some time, having supplied units to augment the Apple II's 140K storage devices.







hree technologies currently exist for removable hard disk and removable media cartridges. The first is the Bernoulli drive, which operates with a cushion of air between the media and the head (see the diagram "The Bernoulli Drive"). The principle employed is similar to aerodynamics, where the convex shape of an airplane wing's upper surface creates lift. As a flexible media diskette spins near a rigid plate or head, the motion of air causes the diskette to it oser to the head, still separated by a cushion of air. Should the disk 'crash," the resulting lack of lift only causes the diskette to fall awa from the head, preventing damage. The trade-off for Bernoulli technology is in wear and tear on the media due to the constant bending of the flexible diskette to lift it closer to the head.

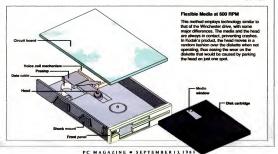
A second approach uses traditional Winchester technology (se the diagram "The Winchester Hard Disk"). With this drive, a rea write head moves across platters to access sectors of the hard disk drive. The mechanism is very fast and virtually indestructible; however, a crash can occur when the read/write head falls onto the disk drive and digs into the platter. Manufacturers guard against this by utilizing varying protective mechanisms, such as auto-parking.

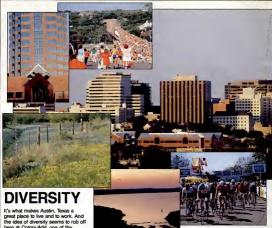
Winchester technology is implemented by manufacturers with removable hard disk cartridges (Sysgen, SyQuest Technology), ovable flexible diskettes (Qume Corp.), and hard drives re from a drive bay (Plus Development Corp.) or from a housing (Tandon Corp.) (see the diagram "Housing System for the Winchester Herd Dlak"). Aristotle Industries, Tradewinds Peripher-als, ProStor, and Western-Dynex Corp, all market drives that detach directly from a computer cable with or without a card

Eastman Kodak's Verbatim utilizes a different technology (see the diagram "Flexible Media at 600 RPM"). A flexible diskette spins at 600 rpm (a Bernoulli drive spins at 1,200 rpm and a hard drive around 3,500 rpm); this diskette is in constant contact with the read/ write head. This approach produces a slower drive but avoids crashes by coupling the disk with the head at all times.

Housing System for the Winchester Hard Disk Tandon's approach to removable media ses a housing unit ith a mechanism for rting and emoving the entire ard disk drive.

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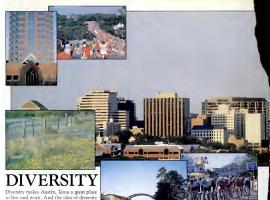
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Career Starter Kit™

Standard-Turbo 10™, PC/XT@-compatible computer with:

- · 4.77MHz and 10MHz switchable speeds
- 8088 processor
- 640KB RAM
- 360KB floppy drive
- Floppy drive controller
- 150-watt power supply Math coprocessor socket
- Eight expension slots
- Choice of AT-style, 5151, or enhanced 101-key keyboard
 Monitor A high-resolution amber monochrome monitor with 12" display and monographics cerd with parallel port. For e

sharper image, try our EGA or VGA color video option. See chart.

Hard Drive - Optional, See chart.

Printer - Star Micronics NX-1000TM provides softwere compati-

PTINTEF - Star Micronics NX-1000 ** provides softwere compatibility plus 12:pps draft and 30cps near letter quality printing, multiple type styles, nine-pin print head, Epson® LX-300 and IBM Proprinter® emulation, dot-graphics capability, and tractor/

friction paper feed.

Software - You'll appreciate Professional Zen'TM. This totally integrated software package includes Zon'Word'TM, ZenCaic'TM, and ZonLink'TM for all of your word processing, spreadsheet, and communications needs. MS-OS® and GW Basic software

complete your system.

Accessories - 200 sheets of continuous form paper, a printer cable, and ten blank floopies get you started.

63717 - \$895

Career S	tarter Kit Option		
	Monographics	EGA	VGA
No Drive	63717	63718	63706
	\$895	\$1295	\$1445
20MB	63707	63708	63712
	\$1165	\$1565	\$1715
40MB	63702	63703	63704
	\$1300	\$1690	\$1840



Professional Starter Kit™

The Standard-286/10™, AT®-compatible computer with:

- 6MHz and 10MHz switchable apeeds
- 80296 processor
 512KB RAM (expandable to 1MB on motherboard)
- 512KB RAM (expandable to 1MB on moth
 1.2MB floopy drive
- 1.2MB toppy drive
 Dual floppy/hard drive controller
- 200-watt power supply
- Math coprocessor socket
 Eight expansion slots
 Clock/calendar with battery backup
- Choice of AT-style, 5151, or enhanced 101-key keyboard
 Monitor A high-resolution amber monochrome monitor with

12" display and monographics card with parellel port. For e sharper image, try our EGA or VGA color video option. See chart. Hard Drive - 20MB hard drive fully installed. Includes free PC-FullBak backup software. For upgrade, see chart.

Printer - Epson LX-800 provides software competibility, plus 180cps draft and 30cps NLQ printing, multiple type styles, Epson Character Graphics set, dot-graphics capability and tractor/friction paper field.

Software - You'll appreciate Professional Zen. This totally integrated software package includes ZenWord, ZenCatc, and ZenLink for all of your word processing, spreadsheet, and communications needs. MS-DOS and GW Basic software complete your system.

Accessories - 200 sheets of continuous form paper, a printer cable, and ten blank floppies get you started.

63725 - \$1515

	Monographics	EGA	VGA
20MB	63725	63726	63724
	\$1515	\$1915	\$2065
40MB	63730	63731	63732
	\$1640	\$2040	\$2190
60MB	63735	63736	63737
	\$1700	\$2100	\$2250

STARTER KITS

Video options

Flatscreen Monographics Combo

This basic, dependable video package is standard equipo on all our starter kits. It includes a SamsungTM monitor with a 12" flat screen and tilt swivel base for easy viewing. The 80-character amber display offers high contrest and high resolution. The monochrome graphics card provides taxt display of 80 columns by 25 lines or graphica display of 720 columns by 348 addressable dots. It includes a parallel port.







Enhanced Graphics Adapter (EGA) Video Option Package

Upgrade your kit with enhanced color graphics. The EGA option package includes an EGA monitor with industry atandard 14" tube size (13" disgonal) screen. The .3 tmm dot pitch provides a high resolution display. The EGA video card has a 256KB display memory and a highresolution (640x350) graphics mode. It displays 16 out of e

possible 64 colors at a time.



Video Graphics Adapter (VGA) Video Option

Package Get the most from your chosen computer kit with the finest color graphics of available technology. The VGA option packaga includes e color VGA analog monitor. The 14" screen displays a spectrum of colors and offers a .28mm dot pitch and 31.5KHz horizontel scan frequency. The VGA video card aupports high resolution (600x600) graphics and displays 16 out of a possible 256 colors

at a time.



· Eight expansion slots Clock/celendar with battery backup . Choice of AT-style, 5151, or enhanced 101-key keyboard

· 200-watt power supply Math coprocessor socket

Monitor - A high-resolution amber monochrome monitor with 12" display and monographics card with parellel port. For a sherper image, try our EGA or VGA Color video option. See chart. Hard Drive - 20MB hard drive, fully installed. Includes PC-FullBak backup softwara. For upgrades, see chart.

12MHz Advanced Starter Kit™

The Standard-286/12™. AT-compatible

Printer - Epson LX-800 provides software compatibility, plus 180cps draft and 30cps near letter quality printing, multiple type styles, Epson Character Graphics set, dot-graphics capability and tractor/friction paper feed

Software - You'll appreciate Professional Zan. This totally integrated software package includes ZenWord, ZenCalc, and ZenLink for ell of your word processing, spreadsheet, and communications needs. MS-DOS and GW Basic aoftware complete your system.

Accessories - 200 aheeta of continuous form paper, a printer cable, and ten blank floppies get you started.

63750 - \$1715

computer with:

1.2MB floppy drive

· Dual flopoy/hard driva

speeds

1MB RAM

controller

0 wait states

80286 process

6MHz and 12MHz awitchable

Advan	ced Starter Kit Op	itions	
	Monographics	EGA	VGA
20MB	63750	63751	63752
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40MB	63755	63756	63757
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 Clock/calendar with battery backup
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- Two 8-bit expansion slots
- 200-watt power supply
 1.2MB floppy drive
- Dual floppy drive
 Dual floppy/hard drive controller
- Dual floppy/hard drive controller
 Math coprocessor socket

HILLITE HE

- for the 80287 or 80387

 Your choice of enhanced 101-key,
- AT-style, or 5151 keyboard • 17.6 on Norton's SI
- 17.6 on Norton's SI Benchmark 4.0 test

63250 - \$2095

Standard-286/12™

Featuring:

- 6MHz and 12MHz switchable speeds.
- O wait states
- 1MB RAM
- · Clock-calendar with battery backup
- Six 16-bit expansion slots
- . Two 8-bit expansion slots
- 200-watt power supply
- 1.2MB floppy drive
- Dual floppy/hard drive controller
- Math coprocessor socket
 Your choice of en-
- Your choice of enhanced 101-key, AT-style, or 5151
- keyboard
 13.7 on Norton's SI
 Benchmark 4.0 test

63177 - \$1245

"We found the Standard Brand-286/12 to be a fast and versatile ATcompatible."

Computer Buyer's Guide and Handbook, Volume V. Issue 5

Monitors optional,

Standard-286/10™

Featuring:

- . 6MHz and 10MHz switchable speeds
- 512KB RAM expandable to 1MR
- · Clock/calendar with
- battery backup
- · Six 16-bit expansion slots
- . Two 8-bit expansion slots · 200-watt power supply
- 1.2MB floopy drive
- . Dual floppy/hard drive
- controller
- · Math coprocessor socket
- · Your choice of enhanced 101-key,
- AT-style, or 5151 keyboard · 9.4 on Norton's SI Benchmark 4.0 test

63150 - \$1045

"Overall, the

- Standard-286/10 appears to be one of
- ues... It comes with a good complement of
- manuals and software
- and performs precisely as you would
- expect. You should be happy with this one."

Alfred Poor-PC Magazine

Choice Feb 16, 1988

Standard Turbo/10™

PC/XT®-Compatible Computer™

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 - Math coprocessor socket
 - · Eight expansion slots
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 - 150-watt power supply · Your choice of enhanced 101-key, AT-style, or 5151 keyboard

63050 - \$595





Monitors optional.

ass storage with mass appeal for AT® compatibles.

Hard drives for AT compatibles include: drive, data cable, mounting hardware, manual, and free PC-FullBak® disk backup software. Hard drives above 30MB come with partitioning software.



Maxter 338MB full-height ESDI hard drive for the 286/386 with an access time of 16ms. Uses 1:1 interleave and has a 10MBit per second data transfer rate. Includes dual floppy/dual hard drive controller 47451 - \$2575

CDC 150MB full-height ESDI hard drive for the 286/386 with an access time of 18ms. Uses 1:1 interleave and has a 10MBit per second data transfer rate Includes dual floopy/dual hard drive controller, 47431 - \$1599

MiniScribe® 110MB full-height hard drive for the AT with an access time of 28ms, Uses RLL encoding, 1:1 interleave, and has a 7.5MBit per second data transfer rate. RLL contra

card included. 47425 - \$895



Seagate® 80MB full-height

hard drive for the AT with an

MiniScribe 71MB full-height

hard drive for the AT with an

access time of 28ms.

access time of 28ms.

47401 - \$695

IniScribe 44MB half-height hard drive for the AT with an access time of 25ms. 47204 - \$459

Seegate 40MB half-height hard drive for the AT with an access time of 28ms. 47207 - \$439

Seagate 20MB half-height hard drive for the AT with an access time of 65ms. 47003 - \$249



47400 - \$849

Floppy drives Floppy drives allow you to store information on 360KB half-height floppy drive removable and portable diskettes. for the PC/XT (black).

> 360KB Teac floppy drive for the AT (grey).

45303 - \$109

45304 - S99 360KB half-height floppy drive for the AT (grey). 360KB Teac® floppy drive for 45305 - S109

the PC/XT (black). 45301 - \$109

720KB half-height 3.5" floppy drive for the PC/XT (black). 45205 - \$109



720KB half-height 3.5" floppy drive (grey). 45204 - \$115



45352 - \$109

1.2MB Teac floppy drive for the AT (grey). 45351 - \$119 1.44MB Panasonic® half-height floopy drive (grey).

45220 - \$135

DRIVES • TOOLS

PC/XT-compatible hard drives are easy on the wallet.

Hard drive kits for PC/XT compatibles include: drive, cables, mounting hardware, controller card, complete manual, and free PC-FullBak® disk backup software.

MiniScribe 20MB half-height hard drive for the PC/XT with an access time of 65ms. 47001 - \$279 Seagate 20MB half-height hard drive for the PC/XT with an access time of 65ms. 47002 - \$289 MiniScribe 30MB half-height hard drive for the PC/XT with an access time of 65ms. 47100 - \$339

Seagate 30MB half-height hard drive for the PC/XT with an access time of 65ms. 47101 - \$310 MiniScribe 40MB half-height hard drive for the PC/XT with an access time of fitme 47206 - \$379

MiniScribe 60MB half-height hard drive for the PC/XT with an access time of 61ms. Has RLL encoding, 4:1 interleave,

and 7.5MBit per second data transfer rate. RLL controller card included.

47250 - \$419 20MB 3.5" half-height hard drive kit suitable for Compag® portables. 47000 - \$299





FlashCard-30 were PC Magazine Editor's Choice, February 20.

FlashCard-49, 49MB Seagate, 28ms. 47208 - \$539 FlashCard-30TM, 30MB MiniScribe, 65ms. 47104 - \$339 FlashCard-20TM, 20MB MiniScribe, 65ms. 47005 - \$319

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STRIKE it rich with the FlashCard-49!™

Uncover the FlashCard-49: vou'll discover a mother lode of high-capacity, highspeed mass storage mounted on a bracket with controller for quick. trouble-free installation.



Computer service kits are handy versatile kits that keep all the necessary tools for maintaining vour computer right at your fingertips.

Basic Tool Kit includes chip inserter, extractor, 3-claw holder, tweezers, four screwdrivers. four nutdrivers, and torque screwdriver in a vinyl case. 41131 - \$9.95 (Reg. \$14) Soldering Tool Kit includes chip inserter, extractor, antistatic wrist strap, colled ground cord, soldering iron, desolder-

ing tool, solder tools, pliers, and dippers in a vinyl case. 41132 - \$35 Advanced Tool Kit includes

chip inserter, chip and square chip extractors, anti-static wrist strap, multiple screwdriver with six extensions, two nutdrivers, and two torque screwdrivers in a vinyl case, 41133 - \$39

Troubleshooting Tool Kit includes chip inserter, chip and square chip extractors, antistatic wrist strap, multiple screwdriver with six extensions, two nutdrivers, two torque screwdrivers, a logic probe, a logic pulser, and a 3-piece tweezer set in a vinyl case. 41134 - \$89

Video combos



Monographics Combo

Includes Samsung 12" flat screen monitor with tilt and swivel base, and monographics video card. 51700 - \$139



Color Graphics Adapter (CGA) Combo

Includes 12" color monitor and color card. 51701 - \$289



Enhanced Graphics Adapter (EGA) Combo Includes a 14" industrystandard tube with 13° diagonal EGA monitor and EGA-350 card. 51702 - \$489

Monochrome ====

Amber and black-and-white perfect start-up video

for comfortable viewing and low price.

Samsung 12" monitor, curved screen amber monochrome monitor. 51000 - \$89



Amdek® 410W monitor, black and white display with 12" flat



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Monographics card is a highresolution monochroma graphics (up to 720x348) card. Includes parallel port. 48301 - \$53

sung TM 12" monitor, flat

screen amber monochrome

with high-contrast, non-glars

screen, high resolution, 80 or

40 character display, and till

Hercules™ Monochrome Graphics Card Plus, mono-

chroma display with high-

resolution graphics (up to

720x348) and text display.

includes parallel port.

48350 - \$179

swivel base.

51001 - \$95



Color ===== IBM-compatible color monitor with 12" screen. 51100 - \$239



Princeton® HX-12+ color monitor with 28mm dot pitch. 77×200 line resolution, and 18MHz bendwidth, 51101 - \$349

Hercules Color Graphics card has color graphics and printer port for lihe AT/PC on a spacesaving half-siza card. 48351 - \$149

Color graphics card is a highresolution color graphics adapter that operates in both color and composite mode. Includes a parallel port. 48302 - \$53



EGA = EGA... the standard for high-resolution

color. IBM-compatible 14° EGA

monitor offers the best value in an enhanced color monitor. Its industry standard 14" tube with 13" (diagonal) screen offers 31mm dot pitch and high resolution. 51201 - \$349

NEC Multisyne® II adjusts to any horizontal synchronization frequency between 15.5KHz and 31.7KHz, Itsupports TTL and analog inputs and resolu tions of up to 800x675. The 14" display has a 30MHz bandwidth and .31mm dot pitch. 51202 - \$679

Video-7 Vegs Deluxe™ EGA card supports EGA, CGA, and monographics displays. Capable of high resolution up to 640x380 (752x410 with NEC MultiSync II or other competible monitors). 48376 - \$229

46176



VIDEO

Upgrade your system with our quality video combos in monographics, color, or enhanced graphics.



Ultimate EGA Combo Includes the NEC Multisync II monitor and a Video-7 Vega Deluxe EGA card. 51703 - SANO



VGA Combo Includes 14" analog color monitor and a Standard Brand VGA card. 51704 - \$689



Zenith VGA Combo Includes Zenith 14" analog flatscreen color monitor with tilt and swivel base and a Paradise VGA card. 51705 - \$989

Paradise EGA-480 is an IBM/ EGA-compatible card with 256KB display memory, and 16/64 color. The EGA-480 automatically configures itself to a resolution of 640x350 or 640x480, depending on your monitor. 48304 - \$199

FGA-350 card is IBM-FGA compatible 256KB display memory, with high-resolution (640x350) graphics mode. Displays 64 colors, 16 at a time. It supports EGA, CGA, and monochrome displays. 48303 - \$159



48303

Standard Brand EGA-480 card is an IBM/EGA-competible card with 256KB display memory, 16/64 color capability, and auto-configuration. 48306 - \$179

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VGA ===== Enhance your exist-

ing system with any of these fine VGA monitors and cards for spectacular color and clarity.

Zenith 14" Color VGA flat screen monitor with tilt and swivel basa provides sharp, clear images and high resolu dot pitch. Uses flat tension mask technology for remark-

tions of up to 720x348. Displays all graphics modes at 31.5KHz horizontal scan frequency, with 25MHz bandwidth and .31mm able chroma, intensity, and hun 51075 - \$759

45,120

Color VGA 14" analog monitor displays a spectrum of colors as infinite as your imagination. The 14" display has a .28mm dot pitch and 31.5KHz horizontal scan fraguency 51076 - \$515

Standard Brand VGA card enhances your monitor with high-resolution (800x600) graphics, 16/256K color capability, and IBM VGA, CGA, and Hercules Monochroma graphics. 48331 - \$220

Paradise VGA Plus™ card provides increased performance for your IBM VGA and PS/2 competibles, attains high-resolution (800x600) graphics, displays 256K colors, 16 at a time, and supports IBM VGA, CGA, and Harcules™ Monochrome Graphics.

48330 - \$269

Video-78 Vega VGA card, competible with all axisting IBM graphic/text standards, has resolutions of 640x480 and 800x600 with 16/64 color capability. Used with an ana monitor, it has 640x480 resolution with 16/262.144 color capability or 320x200 with 256/262,144. Supports popular softwara packages. 48377 - \$299

CARDS

Multifunction cards

Multifunction cards provide a variety of options including additional random-access memory (RAM), ports, and real-time clock/calendars, to increase your system's speed and flexibility.

> 384KB Multifunction card for your PC/XT with 384KB RAM, parallel port, serial port, game port, clock/calendar with battery backup, and utility software. 48710 - \$199

> > AT-Multifunction card with OKB is expandable to 1.5MB and supports either 64KB or 256KB chips. Includes serial and parallel ports. 48701 - \$110

AST Advantage!™ for ATs with 128KB RAM (expandable to 1.5MB). Includes serial and parallel ports. 48752 - \$228 AST SixPakPlus® for PCs with 384KB RAM, serial port, parallel port, clock/

calendar with battery backup, and util-

ity software, 48760 - \$259

Options

Second Serial Port Option for the AT I/O, XT I/O, or AT MFC cards. 48900 - \$15 AST Advantage! Game Port Option for the AST Advantage! 48951 - \$35 AT-MFC Memory Piggyback with 0KB is expandable to 1.5MB RAM. 48901 - \$25 AST Advantage! Serial Port Option for the AST Advantage! 48950 - \$35

Accelerators

Increase your PC's processing speed to

turbo speeds (higher than 4.77MHz) with an accelerator card.

Charge Card 2861M makes your PC/XT run 6.6 time 48602 - \$259



Orchid TinyTurbe 266TM board gives your PC/XT the power of an AT. 48601 - \$279

Memory cards

Extra memory allows you to run more powerful applications and may increase the operational speed of a program.

Mem-578 short card for the PC/XT supports either 64KB or 256KB chips. It comes with 0KB and is expandable up to 192, 384, or 576KB. 48100 - \$35

XT EMS Card (Expansion-Memory-Specification) for the PC/XT, with OKB expands to 2MB and is compatible with the Lotus/Intel/ Microsoft specification, Includes virtual RAM disk and printspooler softwara, 48101 - \$99

EMS Card for the AT is compatible with the Lotus/Intel/Microsoft specification end has 0KB expandable to 2MB, Includes virtual RAM disk and print-spooler software. 48102 - \$119



Input/output cards

Add a serial or parallel port to your system with an economical I/O card.

I/O Card for AT compatibles with serial port and parallel port. VO Card for PC compatibles with serial port, parallel port, game

port, and clock/calendar with battary backup. 48001 - \$85

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Math coprocessors speed up your calculations.

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80287-8 Math coprocessor (6MHz). 50250 - S199

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HARAMAN CONTRACTOR 80287-10 Math coprocessor

(10MHz) 50252 - \$329 An387-16 Math coprocessor (16MHz).

50275 - \$525 80387-20 Math coproce (20MHz) 50277 - \$779

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ACCESSORIES

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Teak office accessories - Personalize your office with these handsome accessories.

Monitor stands 12" Till/swivel monitor stand, 11" x 10". 41565 - \$15 14" Till/swivel monitor stand.

14" x 12.75", 41566 - \$19 System stands



Teak turntable monitor base provides easy viewing. 15.75" x 13.25". 41567 - \$29 Teak disk file for 50, 5.25* diskettes. 41611 - \$25 Teak disk file for 45, 3.5' diskettes.

41600 - \$19



Hewlett-Packard accessories

Transparency pens Plotter paper Five colors, .3mm. Size A, 50 sheets. 35500 - \$5 37550 - \$8.50 Five colors, .6mm. 37551 - \$6.50 Fiber tip pens

4 colors, .3mm. 37500 - \$6.50 4 colors, 7mm. 37501 - \$8 50 6 colors, .3mm. 37510 - \$8.50 6 colors, .7mm.

Size B, 50 sheets. 35501 - 59 PaintJet paper 35510 - \$15.50

Transparency film for the ColorPro Plotter Size A film. 37805 - \$45 Size B film. 37606 - \$45 PaintJet film. 37607 - \$55

Floppy

storage = Cases for 5.25° floppies. Holds 10, 41576 - \$3 Holds 6. 41577 - \$2 Case for 3.5" flopples Holds 10. 41575 - \$3

Portable carry-case w handle for 5.25° floopi Holds 120, with lock. 41617 - \$29

File boxes for 5.25° floppies. Holds 50, without lock 41610 - \$8 Holds 100, with lock. 41615 - S8 Holds 120, with lock. 41616 - SP File boxes for 3.5" flopples. Holds 40, without lock 41598 - \$7 Holds 80, with lock. 41599 - \$10

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ELECTRONICS



Null modems

Null modems are used for in-line connection of like devices. Male to male. 40035 - \$5 Male to female. 40036 - \$5 Female to female, 40037 - \$5

Converters

For communication between different interfaces, use a converter. DB9F to DB25M. 39402 - \$9 Parallel to serial, 39401 - \$45 Serial to parallel, 39400 - \$45

Jumper boxes

Jumper boxes custom design in-line adapters for non-standard ports. Male to female, 40000 - \$8 Male to male. 40001 - \$6 Female to female, 39999 - \$7

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BS232 NULL MODEM

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Mini-Tester (M-F) tests for faulty RS-232 interfaces. 40002 - S9

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6-outlet full surge protector with light and noise filter. 40504 - \$16 4-outlet protector with light and noise filter and EMI-RFI filtration. 40506 - \$16

with light and noise filter and EMI-RFI filtration. 40505 - \$20 RS-232 (M-F) surge protector Curtis Emerald®, 6 outlets. 6' cable, circuit breaker, and warranty. 40529 - \$37 Curtis Ruby®, 6 outlets, EMI-RFI filtered, 6' cable, circuit breaker, and warranty.

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40530 - \$55 Curtis Ruby Plus®, includes modem protection. 40531 - \$65

PRINTERS

Dot-matrix printers =

Epson®

Model LX-800 provides draft (180cps) or near letter quality printing (30cps), multiple type styles, Epson Character Graphics set, and dot-graphics capability. Automatic single sheet load and pull tractor feed. Parallel interface, (80 columns). 56301 - \$205 The FX series 9-pin, dot-matrix printers. Prints 264cps in draft mode and 54cps in near letter quality. Automatic sheet load and friction/pull tractor feed. Parallel interface Model FX-850 (80 columns). 56312 - \$375 Model FX-1050 (136 columns). 56313 - \$549 The EX-800 Prints 300cps in draft mode and 60cps in near letter quality mode. Automatic

sheet load and bidirectional

push tractor feed. Parallel/

56320 - \$476

serial interface, (80 columns),

The LQ series features o 24pin print head that produces letter quality printing. The LQ-500 printer prints 180cps in draft mode and 60cps in letter quality mode. The LQ-2500 printer prints 324cps in draft mode and 108cps in letter quality mode. Both include on 8KB buffer, pull tractor feed, and a Centronics@-compatible, 8-bit parallel interface. The LQ-850 end LQ-1050 printers print 264cps in draft mode and 88cps in letter quality mode. Each includes 64KB buffer. push tractor feed, and serial

and parellel interfaces. Model LQ-500 (80 columns). 56335 - \$365 Model LQ-850 (80 columns). 56334 - \$576 Model LQ-1050 (132 columns). 56333 - \$699 Model LQ-2500 (132 columns).

56331 - 5023

Okidata®

The Microline® 190 series uses either an adjustable nin feed (192 Plus) or adjustable tractor feed (193 Plus). Prints up to 200cps in draft mode and 40cps in near letter quality mode. Parallel interface. 192 Plus (80 columns). 56350 - \$329

193 Plus (132 columns). 56351 - \$479 The Microline 292/293 series reproduces graphics, spreadsheets, and text files using a dual 9-pin print head and a special Lotus@-compatible

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293e Microline (132 columns) 56357 - \$599





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Panasonic® ===

Editor's Choice Nov. 10, 1987

Model 1080l is a 10" printer operating at 120cps in draft mode and 24cps in near letter quality mode. It features proportional spacing, print mode selector, and high-resolution graphics. Adjustable rear tractor feed end friction feed. Parellel interface. (80 columns), 56370 - \$179

Model 1091) prints at 160cps in draft mode and 32cps in near letter quality. This 10" printer, offers all the features of the 1080i with increased speed. Adjustable reer tractor feed and friction feed. Parellel interface. (80 columns). 56371 - \$219 Model 1092l prints at 240cps in dreft mode and 48cps in near letter quality mode with proportional spacing, high-resolution, dot-addressable graphics, and downloadable characters. Adjustable push tractor feed and friction feed. Parallel interface. (80 columns), 56372 - \$349

Model 1592 is a high performance printer that prints at 180cps in draft mode and 38cps in near letter quality mode. Adjustable rear tractor feed and friction feed. Parallel interface. (132 columns). 56373 - \$449

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Model 1595 prints at 240cps in draft mode and 51cps in near letter quality mode. Adjustable rear tractor feed and friction feed. Parallel

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For Panasonic models 1080i, 1091i, 1092i, 1592, 1595, 37976 - \$12 For Star model NX-1000 38066 - S6

Tractor feeds For Okidata model: 192. 37850 - \$49 292e. 37851 - \$46 For Panasonic Mod-1595. 37875 - \$109



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52501

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ing important calls. hine (KX-T1427) is a

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feeding feature for up to 50 sheets. This copier has a 9 multiple copies capability, a 1:1 reproduction ratio, and a warmup time of 18 seconds. Weighs 28 lbs. and measures 5.4" x 14.4" x 16.4", 56151 - \$679 Canon PC3 personal portable copier with single-sheet bypass, a 1:1 reproduction ratio, and a warm-up time of 18 seconds. Weighs 26 lbs. and measures 5.4" x 14.4" x 18.4". 56150 - \$529

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FAX MACHINES

FAX machines

Murata M1200 FAX, Phone & Copier outputs fine-resol raproductions of 203 x 196 lpl at e rate of up to 9600 bps. This portable FAX offers two transmission modes, activity log, and advanced poling features for remote document retrieval. Group-2 and Group-3 compatible. 56070 - \$679



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Contents

Accelerators 12 Answering machines 23 Buffare 15

Cables 18 Calculators 22 Cards (CGA, EGA, VGA) 10-11 Cards (FlashCards) 9 Cards (I/O) 12 Cards (Memory) 12

Cards (Multifunction) 12 Cleaning kits 18 Coprocessors 12 Computers 4-5.6-7 Copy holders 14 Covers 18

Electronic supplies 15 FAX machines 24 FlashCards 9 Floppies 14

Floppy drives & Floppy storage 14 Hard drives 8-9 Hewlett-Packard accessories 14

Jovsticks 18 Kayboards 18 Kayboard drawers 18 Microcassette recorders 23

Modems 17 Monitor stands 14 Monitors 10-11

Mouse devices 18 Order form 13 Photocopiars 23 Printer mufflers 17 Printer ribbons 17 Printer stands 17 Printers 18

PS/2 peripherals 8,14 Softwere 19-21 Communication 20

 Databasa mgmt. 20 Desktop publishing 19

· Education 21 • Finance 20 · Gemes 21

- Graphics 19 Integrated packages 20 Lenguages 20

 Security 20 Spreadsheets 20 - Utilities 20 · Word processing 19

Starter kits 4-5 Surge suppressors 15 System stands 14 Switch boxes 15 Telephones 23 Toner cartridges 22 Tool kits 9 Tractor feeds 17 Video combos 10-11

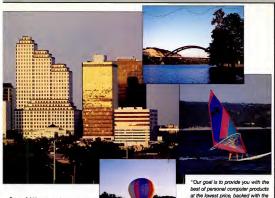


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deserve."

Kodak's PC version of their transportabledisk subsystem stands half-height tall among hard disks, weighs a scant 31/2 pounds, and tips the monetary scales at a medium-range \$800, including adapter card. The drive mechanism and interface card is installed in your PC just as you would install a floppy disk drive. And when you look for the hard disk cartridge, you'll certainly be disappointed. Kodak has chosen to use modified floppy-disk drive technology for its portable system. The cartridge is a 51/4-inch disk wrapped in a self-lubricating jacket and encased in a hard plastic shell-much like a 31/2-inch disk swollen to standard floppy-disk pro-

portions.

But that's one of its few similarities to standard 5¼-inch disks. Kodak applies a slightly different technology to its cartridge from what you'd find in a typical floppy disk drive. To begin with, the disk spins at 600 rpm—wice as fast as your



Verbatins 12MB Internal Subsystem Eastman Kodak Co. Mass Memory Division 343 State St. Rochester, NY 14650 (716) 724-5130 List Price: \$800; cartridge, \$25. Requirers: IBM PC, XT, AT, or compati DOS 2.1 or later. In Short: The Verbetism 12MB unit from

Eastman Kodak gets high marks for using advanced floppy disk technology to produce a reliable mass storage device. Unformantely, its data throughpur rate lessens its effectiveness in an AT environment, making the Verbutin more suitable as a data-archiving de-

CIRCLE 881 ON READER SERVICE CARD

PC

Benchmark Tests: Removable Mass Storage Devices

W e tested 13 removable hard disks and removable disk cartridges. Results were then normalized against the IBM PC AT 30MB disk's times. Manufacturers whose products performed well in these benchmark tests have last file access, disk access, and IBM OOS disk seek functions; products toward the lower k functions; products

spectrum were slower in these categories. All units were tested with DOS 3.2, with the exception of the 40MB SyQuest SQ555 SyQuest Technology does not supply a device driver to access the disk beyond the 30MB limit imposed by DOS 3.2 and recommends that DOS 3.3 is used with the

lomega's Bernoulli Box II, Tandon's Ad-Pac, and Sysgen's Internal and External OuraPake could not run our BIOS Disk Seek test since none uses standard ISM BIOS calls. Eastman Kodak's Verbatem 12MB Internal Subsystem was also unable to run the BIOS Disk Seek test because its varying sector count scheme produces erroneous results on our test.

The fastest results on the DOS Disk Access test came from the SyQuest SQ555 followed by the ProStor TransPac and the Plus Development Passport. For the DOS File Access test using large

records, the Ad Pac came out sheed. Next was the TransPac, then the \$\(\)\ Quest SOSSS, and then the Passport. The DOS File Access for small records test results were featest for the Ad Pac, the TransPac, the Passport, and the \$CSSSS.

The benchmark test measuring the speed

of e BIOS Disk Seek using Disk BIOS accessing random records produced three familiar winners: the \$C655, the TransPac, and the Passport. Why do these four products—the Passport the \$V_QUest \$C655, the \$Ad Pac,

The BIOS Disk Seek benchmark test measures the time it takes to do a random seek using the disks ROM BIOS. The test result include minimal software creating and may not parallel the minutesturie's claimed average access time. The set program performs 1,000 seeks. The average result is shown in miliscocords.

e DOS Disk Access benchmark test measures the time it see to do a random sector read using DOS. DOS buffers see at 23 and the interferor factor is left at the drive's fault setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the salton and 5.000 times within the DOS disk partition. The average will be shown in collisionnovie. and the TransPow—term in faster performmone times on our brechmerk sets if For one thing, the first three products mentioned use the quicker RLL (un-length-intered) encoding scheme. Of the other removable mass storage units tested, the Berouldi Box II and the Dural Pals also use RLL. The Berouldi 1.200 ppm, rether than approximately 4.500 spm, as do the Winchester disks.

Individual vendors also have various methods to improve disk speed. Tandon, for example, uses a 128K hardware memory cache through the RLL controller, greatly speeding up is Ad Pec's access time. ProStor's TransPac has an extremely fast read-write mechanism. In addition, all the wirners have low interleave factors, a known

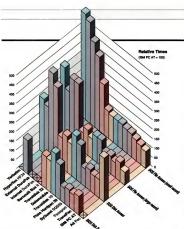
ruits for large records to 48.66 seconds

from 65.74 seconds. The same test for small records produced an improved time of 154.85 seconds, which was reduced from 283.61

The DOS File Access benchmark lost measures the throughput rate of the dalk being tested. In this case, throughput time are measured in terms of how long tasks to perform opinion DOS file—measurement of the third. Five tasks—file creation, sequential file write, sequential results, and the sequential results and the sequential results.

rised, random file write, and random file read—see time the results assumed.

The lest is carried out to the different types of lise—small-incost files and largo-mood files—that are by dominion PC applications. Thes created using small records are plycially used by disclasses management programs, and largo records are typically used for word processing and greatenined files. Louding a DOS programs, and presented files. Louding a DOS programs.



Performance Times Times given in seconds except where noted)	BIOS Disk Seek (milliseconds)	DOS Disk Access (milliseconds)	DOS File Access (large record)	DOS File Access (small record)	
Varbatim 12MB Internal Subsystem	N/A	124.04	71.14	405.92	
Hyperliex HF24	66.58	114,14	50.32	388.72	
External DuraPak *	N/A	199.52	65.76	324.90	
Internal DuraPsk *	N/A	175.30	65.74	283.61	
Bernoulli Box II	N/A	69.06	19.11	191.85	
Traveldisk 22 (Model 2)	64.17	81.01	25.72	103.91	
Datemodula	63.00	71.73	20.45	96.17	
Traveldisk 10 (Model 1)	85 01	98.46	26.31	96.01	
Pisto Hardpac 20	70.08	85.74	26.64	95.77	
SyQuest SQ555	30 65	40.66	16 63	89.50	
Passport	35.00	47.53	18.24	88.15	
TransPac	32.17	41.07	15.27	79.19	
IBM PC AT, Model 339	37.42	42.77	19.31	71.89	
Ad Psc	N/A	100.35	13.28	64.18	

N-A-Not applicable, product could not perform test.

* Results obtained without disk caching.

floppy disk drive. This decreases access time. Next Kodak varies the sector count, putting fewer sectors per track near the hab of the disk than at the outside rings near the edge to improve accuracy at the faster rotational speed. All of these changes add up to a floppy disk in a hard shell that holds 10MB of data and sells for under \$50.

IMMI of data and sells for under \$50. The installation was quite simple, alfloopy-disk system, one of your drives must be removed in favor of the Kodak mechanism. (A drawback to all removable media acherne is that you need access to squack by the problem with the two large drive bays on an XT and still maintain a dual-floopy system, but dual-floopy at Youness are not that fortunate.) Using the supplied mounting rails, the Verbatium position in my AT now wearant b drive position in my AT now wearant b drive

Perhaps the most difficult part of the installation was setting the jumpers on the host adapter card so that the Verbatim drive would know to which type of machine it was connected. The explanations in the manual are quite good, and, following the instructions, it took about 20 minutes to accomplish the entire installation procedure and transform my floppy-diskbased machine into a 10MB hungry monster. (Depending on which boards you have installed, you might also need to do some card rearrangement-the Verbatim 12MB data cable from the host adapter board is very short.) Once the board was connected to the drive, I installed the necessary software from the disks that Kodak supplies, specifying whether I wanted the Verbatim 12MB drive to be bootable or nonbootable. And that was it for the instal-

Of course, as reliable as standard MFM-encoded floppy disk technology is, there are still some drawbests. Even with the increased rotational speed to expedite its mechanical activity (the Verbatim JEMB is rated at 25 milliseconds with a 50-ms. head latency for a total track-totack access speed of approximately 75 ms.), actual data throughput suffered compute make it he slowest drive in the modified floppy-disk technology. You modified floppy-disk technology. You sain a certain amount of indestructibility.

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but you lose a small amount of performance in the process. In an XT environment the data drag might very well be unnoticeable, but in an AT world of 30-ms. hard disks, the Verbatim 12MB is sadly lacking as a day-to-day storage device.—Bill O'Brien

IOMEGA CORP.

Bernoulli Box II

lomega Corp. has, over the years, gained a reputation for innovation in its approach to disk storage technology. Now the Bernoulli Box II packs the same technology as did the earlier Bernoulli drive into a smaller box that uses sleek 20MB eartridges. These new, slimmer 54-inch eartridges are lighter but just as durable as the originals.

The Bernoulli principle, as applied to lomega's Bernoulli product line, relies on airflow dynamics to maintain a constant distance between the flexible-storage media and the drive's read/write head. Hard-

FILE ---Bernoulli Box II Iomega Corp. 1821 W. 4000 South Roy, UT 84067 (801) 778-3000 List Price: Single drive, \$1,440; dual drives, \$2,350; cartridge, \$83. Requires: IBM PC, XT, AT, or compatible; PS/2 Model 50 adapter card: DOS 3.0 or lat-In Short: The new Jomesa Bernoulli Box IL. a down-sized version of the original, uses sleek new 20MB cartridges. Although Bernoulli technology favors large-record applications over machine-gun-like disk-access needs, it's the practical solution for those who need multiple removable units.

CROLE 652 ON READER SHITWOOD CA

ware and media never physically touch. The immediate benefit, of course, occurs when your system crashes (which hopefully will never happen). Because the airflow is holding the media and head in close proximity, crashing the system (or turning of the power) cuts off the air supply, allowing the two antagonists to separate rather than collide.

I'm tempted to make a comparison between the "If-U-Can-Draw-This-Picture" ads and the simplicity of installation for the Bernoulli system. The truth of the matter is that along with its new generation of hardware, Iomega has gone a long way toward making its installation software bulletproof. All you have to do is answer a few questions in response to a series of onscreen prompts. (Unlike some of the other removable systems we looked at. Iomega couches its installation routines in a visually pleasing form that bears little resemblance to the raw batch-file approach that other companies use). However, the installation procedure will modify your CONFIG.SYS file to include the device driver that the Bernoulli Box II needs in order to be accessed by DOS.

Iomega supplies its own SCSI host adapter card, and the external unit, capable of handling two cartridge drives, draws no power from the computer.

The only problem with the Bernoulli Box II rests with its device driver, Ionega has gone to no great pains to make its box totally hardware compatible with the PC—bence the box does not respond to in-terrupt 25th calls. Since the PC Labs benchmark test used to determine track-to-mack access time, the BIOS Disk Seck test, relies on the interrupt 25th call, we were table to obtain results for the Bernoulli.

Missing this performance component isn't disastrous, but any program using BIOS interrupts may have problems with the Bernoulli (fortunately, few programs do). And throughput results for the Bernoulli Box put it right in the midrange of the group of cartridge systems we tested.

A quick look at the test results, however, may surprise you: the Bernoulli Box II is much faster when reading a few large records than it is reading many small ones. The answer lies buried in the unavailable track-to-track access times. When reading several small records, the speed at which

the read/write head accesses a record is affected not only by the physical time it takes to to arrive at the record, but also by the farties of drive's latency, or the time it takes the head to settle down once it begins to access a when reading many small records, while the record. Latency becomes a major issue when reading many small records, while the record takency becomes a decision of the set of the major to the set of the set of the set of the set of the head more contiguous access to the media. Set of the set of the The Bernoulli Box II is a wise choice if

your removable mass-storage requirements include accessing many large-record data files. As for durability and reliability, Bernoulli technology has withstood the test of time.—Bill O'Brien

QUME CORP. Hyperflex HF24

Often it's the background that is the most interesting (and sometimes most perplexing) side of the computer industry—yet it's something end-users seldom get to see. Years ago, Data Technology Corp. (DTC)



disk substitute that uses enhanced floppy-disk

technology, It's not for an installation that

needs to use the Great American Database,

but it can be used for PC upgrades.

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Black Monday Can Teach Us A Lot About Hard Disks.

DROPS

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Fifth Generation Systems, Inc. 11200 Industriplex Blvd., Baton Rouge, LA 70809 Sales Office: 1322 Bell Avenue, Suite 1A, Tustin, CA 92680 • (800) 225-2775 • (714) 259-0541 had a TeamMate division that sold highdensity disk drives, both as OEM united directly, for Apple computers. It was a joint venture of sorts with Eastman Kodak Co. and never really amounted to much in the Apple world. Now, DTC produces while Kodak supplies the media through its Verbaim division. And to let it all together, DTC has just purchased Qume Crp., a company that it owned and sold 11 years ago. Hence DTC will now be Committed.

All of which explains why PC Magazine received a Hyperflex HF24 (the model number indicating a Hyperflex drive with a 24MB unformatted capacity) in a box labeled Take from the name of the old line of DTC 10MB drives) with documentation labeled Covrette (the DTC in house code name for the new, larger-capacity product).

An external housing made the HF24 stightly easier to set up than its leavecious stilling. Eastman Kodds *Verbating. 12MB. Recause it was an external unit, I had no worries about short data cables or in exchange for 20MB of storage. As with the Verbatin 12MB linema \$Shoystem, the installation software for the Hyperflex HF24 handled all of the difficult solit leaving me to decide only whether I wasted the eartifules of the best of the con-

Qume's Hyperflex HF24 is affected by the same pluses and minuses as is Kodak.* S. Verbatim 12MB. It's floopy disk technology is reliable and durable, but the data throughput rates for floopy disks (and for any device that uses the same technology) are just plain slow. The PC Labs tests on the HF24 pegged it as being dightly faster than the Verbatim 12MB, but it still ran close to the end of the pack in most tests.

Qume has done all that it can to offset the negative effects of floppy disk technology by increasing the rotational speed of the drive to 720 pm, prior 600 pm on the Verbatim 12MB, and more than double the standard 300-pm rotational rate of a standard 1909. The drive is rated at a 25-millisecond head access time with a 425-millisecond head access time with a 42m. Statency for a total track-to-track access speed of 67 ms. That's certainly faster than a PC-XT drive would operate, but also

slightly slower than a standard AT-type hard disk. Unfortunately, it's throughput that describes a drive's actual performance

in the real world—not mechanical speed.
On the brighter side, carrying around one of the lightweight HF24 20MB carridges is much simpler than toding a 2-pound removable disk. Also, a 20MB, the HF24 becomes eligible for some enhancements that might help its sluggish throughout. Practically any caching story of the country of the property of the prop

An important point is that the HF24 passed the PC Labs DOS Disk Access and BIOS Disk Seek tests. (as did the Verbation 12MB). Normally, a storage device using a device driver has difficulty with these two tests because they use the standard IBM BIOS disk interrupts 13h and 25h, respectively. The HF24 dose a fine job of intercepting these calls and passing them along to its device appropriately.

I can't wholeheartedly recommend the HF24 for a daily disk-intensive AT environment as is. But if you're running one of the older 6-MHz machines, or an XT, or are willing to invest in competent caching software for an AT that's not heavily used, it might be a unit you should seriously considet.—Bill O'Brien

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As Aristotle once said, "Plato is dear to me, but dearer still is data." Well, maybe he didn't say it quite that way. But whether you need to lock away your data or lug it around with you, Plato—the Plato Hardpac 20, that is—could become just as dear to you as the data it contains.

The Hardpac 20, which hails from Canada's Aristotle Industries, is one of the few truly external portable hard disks on the market today. It supplies 21.4MB of formatted storage capacity at a list price of 5785. (It should be noted that at the time of this writing, FCC approval was still pending on both versions.) disk (another portable, external hard disk reviewed in this issue), the Hardpace's lightweight (2.2 pounds), compact (2 by 4.65 by 7.25 inches, HWD) design makes 4.65 by 7.25 inches, HWD) design makes data and taking in the new for propering data between systems. And if you're leaving town but your data isn't, it's a simple matter to store the diminutive Hardpac 20 in a safe place until you return the drive's 20MB capacity also makes this a worthy product to use for backing up your

Unlike most hard disks, the unit does not interface to a separate proprietary or standard IBM controller card. Instead, an Adaptec chip, fitted on the same board as the electronics of the unit's half-height Miniscribe drive, acts as the controller.

The Hardpac 20 gets its power (12 watts peak, 7 watts average) and talks to the system processor via a host adapter card that can be installed in a half-length PC, XT, AT, or PS/2 (Model 25 or 30) ex-

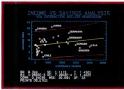


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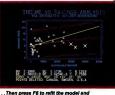
(604) 522-9880 List Price: \$785; host adapter kit (includes adapter card and cable), \$95. Requires: IBM PC, XT, AT, or compatible; DOS 2.0 or later. In Short: its small size and medium-range

access times make the Hardpac 20 a worthy enough performer for most users' transportation, backup, and protection needs. It can also withstand everyday bumps and bruises, but beware of dropping it.

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umber of usable cylinders	304	613	614	615	301	611
umber of usable heade	4	4	4	4	2	4
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PHYSICAL CHARACTERISTICS OF REMOVABLE MEDIA						
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Hyperflex HF24 Ourne Corp. \$1,034*	ProStor Inc. \$1,095*	SyGuest SQ555 SyGuest Technology \$1,005"	Corp. \$1.454*	lomega Corp. \$1,523*	Syspen Inc. \$1,610*	Sysgen Inc. \$2,610 (dual drive)*
Removable flexible cartridge	Removable hard disk	Removable hard cartridge	Removable hard disk	Removable flexible cartridge	Removable hard cartridge	Removable hard cartridge
506	615	1,275	612	498	610	610
2	8	2	4	2	2	2
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8 az.	1 lb. 9 oz.	8 oz.	2 lbs. 8 oz.	5 oz.	5oz.	5 oz.
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together, Passport gives you a powerful way to improve both security and productivity. Call the Plus Product Support Line at 1-800-826-8022. We'll send you a brochure, free, explaining what makes Plus Passport the most powerful hard disk ever released.

Plus

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pansion slot. A 4-foot cable furnishes the connection between the adapter card and the Hardpac 20. If you're using the drive on more than one system, you'll need to outfit each system with its own host adapter card. Aristotle Industries offers the host adapter kit, which consists of the card and cable, for \$95.

QUIET WHEN ACTIVE The Plato Hardpac 20 is a model of quiet operation. Some slight whirring noises and a flashing red indicator light let you know when the Hardpac is active, but other than that, you'll hardly notice the drive above the

hum of your computer. It's easy enough to install the Plato Hardpac 20, although you'd never know that from the preliminary documentation we received. All you have to do is ensure that the jumpers on the card are set in the correct position (depending on whether you are installing the unit as drive C: or D:). Although the disk we received had been high-level-formatted at the factory, the units are usually shipped with only a low-level format. You must partition the disk using FDISK, and then high-levelformat it using the DOS FORMAT command.

To ensure that the unit will be downwardly compatible with XT-type machines, the manufacturer recommends that you format the Hardpac 20 as drive C; on an XT computer. However, the test unit, which I formatted as drive C: on an IBM PC AT, worked quite well when hooked up to an IBM PC-XT.

As long as you have formatted the Hardpac as drive C:, it automatically configures itself as the next available drive if used in a machine with either one or no hard disks. However, if you have originally formatted the disk as drive D:, it will not boot when connected to a system without a hard disk. If there are two physical hard disks already present in the system, you will not be able to access the Hardpac 20.

Aristotle Industries also warns that you may not be able to access the drive if it is used on a machine with a DOS version that is different from the one installed on the Hardnac 20

The drive uses a modified ST-506 interface and an RLL coding scheme, and the area every 30 seconds of nonaccess time. The two platters found in the unit are coated with thin film rather than ferric oxide. The Hardpac 20 also uses a band-stepper mechanism as opposed to the higher-performance servo-voice-coil actuators.

Even so, you shouldn't be disappointed in the performance of the Hardpac 20. While it certainly is not the speediest of the disks we reviewed, it did achieve solid midlevel access times in most of the PC Labs benchmark tests.

WITHSTANDS 100G SHOCK The manufacturer claims that the plastic-covered Hardpac 20 can withstand shock up to 100g. From personal experience, I can report that the unit holds up admirably well under many strenuous conditions, such as being shaken and moved around while in operation, as well as being rather carelessly transported across the hallways of the PC Magazine offices.

However, it did not manage to survive the ultimate test: a drop from 21/2 feet. To be fair, it is made quite clear in the manual that although the unit can survive everyday bumps and jarrings, you should do your best to avoid dropping it. This is simply commonsense advice; unfortunately, the chance of dropping a unit that is designed to be portable and therefore subject to the

rigors of transportation is very real While the Hardpac 20's midrange access times and sensitivity to major shocks may not earn it an Olympic gold medal, it is a reliable enough unit to meet most users' data transportation, backup, and protection needs .- Jennifer Zaino

PLUS DEVELOPMENT CORP.

Passport Plus Development Corp. has earned a rep-

utation for innovation and engineering prowess with the Plus HardCard-the original, and still unequalled, hard disk and controller on a one-slot card. Plus Development's latest wonder, Passport, promises to revolutionize our ideas about hard disks even further.

The Passport sports the same 40-millisecond, wedge-servo-disk mechanism as its distant cousin, but adds speed enhancements and additional shock protection.

FACT FILE

Passport Plus Development Corp 1778 McCarthy Blvd. Milpitas, CA 95035 (408) 434,6900 List Price: Internal unit. \$659: external unit. \$399; Micro Channel bus PS/2 unit, \$759; 20MB disk, \$595; 40MB disk, \$795. Requires: IBM PC, XT, AT, or compatible; DOS 3.0 or later In Short: Passport is an intelligently designed removable hard disk built for high performance and portability. Its speed and durability make it an ideal technology for any application, but the cost of buying additional removable units limits its cost effectiveness for applications that call for several interchangeable disks per system CLE 645 ON REACER SERVICE CA

enough and tough enough for briefcase duty, but fast enough for power computing. In true Plus style, you'll also find a convenience feature or two that you won't find in any other disk-removable or otherwise

The removable disk itself measures about the size of a VHS tape case, weighs 2.4 pounds, and motors into its external or half-height internal housing much as a video tape installs into its player. Though rated to take shocks of 150g, each disk comes with a convenient, padded carrying case. An access indicator light rests in plain view on the front of the housing. To eject a disk, you press a button on the front of the unit or issue a software command: after automatically parking and locking the read/write heads, the unit slides out.

A separate run-length-limited (RLL) controller, complete with a full-track bufffour heads automatically park to a mondata. The result is a removable hard disk small. er, runs the disk at a 1:1 interleave, allow-

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ing data transfer rates more typical of a 28ms drive

The drive mechanism itself, contained within the removable unit, features a voice-coil actuator with an imbedded servo control and Plus's Airlock automatic head-parking technology. Even if power goes down during a read/write operation. Airlock automatically moves the heads to a nondata area of the platters and locks them into place.

Plus's straightforward and generous documentation makes installing the system easy, provided that you've mastered the screwdriver and don't run at the first sight of PC innards. After installing the RLL controller and the system housing, you need only DOS format and partition the disk; the units ship low-level-formatted to match the controller. You can use DOS's FORMAT and FDISK commands or Plus's PREPARE utility, which auto-

mates the procedures. Owners of IBM PC ATs with a BIOS dated 1/10/84-typically the original 6-MHz models-will also need to run a Plus utility that patches the IBMBIOS.SYS file. This should be viewed as an advantage of the Passport rather than a disadvantage; some products, such as ProStor's TransPac, simply don't work with such machines.

PASSPORT TO PLEASURE Aside from its compact design and speed, the Passport boasts a number of features that make life with removable mass storage a hreeze.

For instance, the Passport allows you to set whether or not the Passport will be the boot disk by adjusting a sliding switch on the back of the removable disk. This means that you could install the Passnort as the second or third drive in a system and, by moving one easy-to-reach switch, temporarily designate the Passport as drive C:..

While this feature will undoubtedly appeal to the indecisive among us, it's also useful for running different operating systems on the same machine. You could, for instance, maintain DOS on your stationary system drive and install OS/2 on a Passport disk. Switching to OS/2 would be as simple as ejecting the Passport, sliding the switch to the boot position, and resetting your system.

Each removable disk also sports a write-protect switch on its rear panel, for those times when you just don't trust yourself or your coworkers with irreplaceable data. Another fool-proofing feature, the LOCK utility, locks the disk into its housing as a safeguard against accidental ejects-a potential problem in network installations

An optional battery holder installs into the base housing and accommodates a standard 9-volt battery. The battery supplies power only to the disk-eject mechanism and allows you to eject the Passport

disk even if you lose system power. Our evaluation unit not only ran flawlessly during official PC Labs testing but also passed a few unofficial tests that-

 The Passport comes with adapters for the XT/AT bus or for the PS/2's Micro Channel architecture.

you guessed it-you wouldn't want to try at home. For instance, twice I dropped our 40MB evaluation unit-not wrapped in its foam-padded carrying case-from a height of over 1 foot onto a hard countertop. The unit operated fine afterwards. though it sounded as if the bearings may have suffered damage. Then I slid the Passport into its carrying case and dropped the unit repeatedly from a distance of about 3 feet. Once again, the disk operated per-

It's not likely that your Passport will suffer such falls-and Plus encourages you to treat the disk as if it were a 35mm camera-but it's nice to know that you won't lose months of work if you have butterfingers at the wrong time.

IDEAL FOR BACKUP SECURITY Plus Development offers the Passport with adapters for the XT/AT bus or for the PS/2's Micro Channel architecture, making it an excellent choice for transporting

data between the two standards. A fast iroage-backup program also makes the drive ideal for backing up other hard disks. Last but not least, the Passport's quality and portability make it ideal for high-security applications and for toggling between two operating systems-such as OS/2 and

DOS-on one machine. The Passport also has its drawbacks, however. Like the Plus HardCard 40, the Passport prohibits you from performing a low-level format on the disks. Plus claims that its testing and error marking of the disks is so exhaustive that end-user lowlevel formatting would only cause problems. Regardless, some users-this one included-will resent not having the ability to low-level-format the disks

In addition, the Passport's significant cost may disqualify it from applications that call for more than one or two removable disk units per machine. The cost of installing a Passport on a system is in line with the cost of getting started with a Bernoulli Box II, but the Passport quickly becomes more expensive once you begin adding new removable disks. At \$795 per 40MB disk and \$595 per 20MB, you'll probably be spending more than you bargained for if you use Passport to expand storage canacity

All in all, the Passport unquestionably rates among the most intelligently designed products I've seen, period. It's small, tough, fast, and highly portable-everything you want in a hard disk, removable or otherwise. - Mitt Jones

PROSTOR INC. TransPac

The ProStor TransPac attaches a lightningfast disk mechanism to a three-sided plastic mounting. The assembly slides manually into an inexpensive half-height housing.

Unlike the other systems we tested, the TransPac attaches to your system's existing ST-506, MFM controller. While using a 5-megabit-per-second controller would seem to make the drive a slow performer, the system's 28-millisecond access time overcomes that limitation and makes it rank high among the disk subsystems we

tested. Unfortunately, speed and a mechanical disk lock are about the only things this sys-

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cables), it's expensive. And additional disks will cost you just as much. The 32MB Peripherals Technologies

Inc. (PTI) disk carries a shock rating of pany safe.

tem has going for it. At \$1,095 (including | 80g and boasts true automatic park and lock. But without an enclosure to help buffer shocks, I wouldn't feel comfortable taking this unit much farther than the com-

In addition, figuring out how to install the disk in your particular system can be difficult. That's partly because the system doesn't come with its own controller-ProStor can only guess at the exact configuration of your computer. But the one page of printed instructions that accompanied our unit was insufficient even for knowledgeable users.

A more extensive set of installation guidelines is included on the TransPac software disk, along with Disk Manager software, but the instructions were peared more for a technician than an end user and were poorly written, as well.

Once past the hardware installation, the conspicuous lack of documentation once again caused problems. First, you have to configure your AT for a second disk drive and low-level-format the disk, yet nowhere does ProStor tell you which drive type to enter or give you the information you need in order to venture an educated guess. If you out to use the Disk Manager software to prepare the disk, you'll get a menu with several specific drive models to choose from. Still, the menu shows several



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models of PTI disks, and neither the documentation nor the disk itself revealed the appropriate model number.

In all fairness, ProStor customer support was knowledgeable and courteous, but the pleasant surprise of such customer service didn't make up for the frustrating lack of documentation.

If you can get through the installation process with your sanity intact, and if all you want is the ability to tuck your disk away safely at night, the TransPac will undoubtedly fill your needs. It delivers unquestionably high performance in a halfheight package.

ProStor also markets several other TransPac models, including a Seagate drive and SCSI interface that also sell for \$1,095. Several drives will work with either a PC/XT/AT compatible or an Apple

ther a PC/XT/AT compatible or an Apple Macintosh.

A year ago, the TransPac might have been a hot product. Even now, the SCSI- ■ The TransPac delivers unquestionably high performance, but why spend \$1.095 when you can

\$1,095 when you can spend less on products that offer greater speed.

based version undoubtedly delivers performance that few fixed disks could match. At least with the TransPac, however, the question you should ask is, why spend \$1,095 on the TransPac when you can spend less on products that offer greater speed, more rugged designs, and an allaround more-elegant solution to removable mass storage?—Mitt Jones

TANDON CORP. Ad Pac

With the Ad Pac external disk housing and the Personal Data Pac removable disc combination, Tandon Corp, has devide combination, Tandon Corp, has devide one of the fastest, toughest, and least expensive removable hard disk systems. Rather than depend on an expensive servo mechanism to gain speed, as does Plas Development Corp, with Passport, Tandon depends on a large hardware disk cache to the teach maximum throughput out of defashioned—and inexpensive—band-stepper disks.

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which contains the actual disk mechanism carries a list price of \$399-about \$400 less than a 40MB Plus Passport disk.

A Data Pac measures 2.5 by 4.7 by 7 inches (HWD) and weighs 2 pounds 10 ounces. Though thicker than Plus Development's Passport, the Data Pac transports easily and is built to travel. Tandon places the shock rating at an unheard-of 300g, thanks to heavy shock mounting and a mechanism that actually lifts and locks the heads away from the platter surfaces. Other removable disks reviewed here park, and sometimes lock, the heads on a nondata area of the disk, but the delicate heads still rest on the platter surface and can be damaged during severe falls. Like the Passport disk, the Data Pac

smoothly motors in and out of its recentacle. The receptacle accepts the disk automatically once you've partially inserted it; you issue a command or a key combination to eject the disk. This automatic loading could present problems if the eject motor fails since there is no easy way to manually eject the disk.

NO DATA DANCING But the powereject approach boasts advantages as well. Since making sufficient contact with the connector depends on the exactness of the feeder mechanism rather than the brute force of a manual insert, wearing down the connectors is not a problem. More importantly, the eject routine automatically parks and locks the heads before the disk ejects, ensuring that the heads won't be tap dancing on your data when you dash through the airport toward your departing

The ST-506, RLL controller includes a 128K hardware disk cache-one of the secrets of the Ad Pac's field-leading performance. When the controller receives a request for data, it saves a time-consuming disk access by fetching the data from its own RAM if the requested data is already in the cache. If not, the controller instructs the disk to read not only the sector the system requested, but also the full track containing that sector and the next seven tracks. The eight tracks of data are then tucked away in RAM, awaiting the likelihood that the next read request or two will fall within the eight-track range. Since a disk can read eight tracks sequentially



much faster than it can read them upon separate request, the cache boosts throughput significantly. Several other products incorporate similar caches, commonly called look-ahead buffers, but most can hold only half or a single track of data.

systems we tested. It also offers a combina-

removable hard disk could match

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tion of economy and ruggedness that no other

Though PC Labs rated the mechanical speed of the Data Pac at about 85 milliseconds (100 ms. using DOS sector reads), the overall throughput was the highest of any removable mass-storage system we

Installation of the Ad Pac hardware is as easy as snapping in the controller board. plugging in a spare power lead from your power supply, and hooking a cable from the controller's port to the external receptacle. The dream of hassle-free installation begins to fade once you boot up your system and begin preparing the Data Pacs for actual use. In short, instead of integrating nicely with your system, the Ad Pac moves in and takes it over. The blame belongs with a persistent and bothersome series of menus. Tandon's spotty installation documentation, and disk initialization

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commands completely different from the commands DOS provides.

Once up and running, our evaluation unit performed just beautifully under normal working conditions and even proved fun to use

After concluding our official testing, we couldn't resist testing the Data Pac's ability to survive a fall. With a shock rating of 300g, the Personal Data Pac invites brutal testing

SCHOOL OF HARD KNOCKS First. we dropped two Data Pacs from a distance of about 16 inches onto a hard countertop. Both to our surprise and Tandon's, neither unit worked after the fall. As it turned out. an apparent design flaw in the mounting of the ribbon-cable connector can cause the connector near the rear of the unit to fall out of alignment during severe shocks. The disks required only a simple fix: removing three screws, lifting off the plastic

end-panel, and realigning the connector. Tandon is aware of the connector's potential to be shocked out of alignment and is working on a fix.

■ The Ad Pac automatically parks and locks the heads so they don't tap dance on your data when

Next, we took the drop testing to an extreme. Following the example of a Tandon salesman at a recent computer exposition, I casually tossed a Data Pac over my shoulder, turning in time to watch it bounce on

you dash to your flight.

the hard rubber floor of PC Labs. The plastic end-panel suffered two cracks, but the disk whirred into its receptacle and went to work without complaint. This time, the connector hadn't even shaken loose.

Tandon's advertised 300g rating actually governs the disk mechanism itself. Cracks in the plastic casing may render the disk unusable at lesser shocks. But a plastic casing is much easier, and cheaper, to replace than a disk mechanism. And, if our tests are any indication, you need not worry too much about either if you treat your Data Pacs with some amount of respect.

Like Plus Development's Passport. Tandon's Ad Pac system includes a command that allows a quick backup of a disk onto a Data Pac. However, the Ad Pac's backup command works only from one Data Pac to another. You'll have to buy two recentacles or Tandon's dual-disk receptacle if you want to take advantage of this feature.

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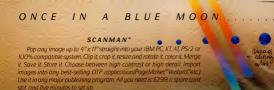
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The Ad Pac shares the same cost-effectiveness limitations as do the other removable hard disk products: if your applications demand more than one or two memovable disks per station, the cost becomes outrageous compared with the cost of products like the Bernoulli Box II. On the other hand, if you need the speed of a removable hard disk product for such an application, the Ad Pac is by far the least-expensive of the group.

Aside from the annoying software installation and the problem with the loose connector, my only major complaint with the Ad Pac concerns its lack of true autoparking. Though it does an excellent job of lifting and locking the heads each time you eject a disk, the Ad Pac's head-parking mechanism won't avoid thead crashes when you turn off your system or during sudden power loss.

The Ad Pac includes MS-DOS 3.2 (or later) and Tandon's Personal Data Pac Utilities. Each Personal Data Pac ships with Tandon MS-DOS, GW-BASIC, and Microsoft Windows already installed.

Tandon markets two 80286-based machines—the Pac 286 and the Pac 286 Plus —with built-in receptacles for the removable Personal Data Pacs.

The Ad Pac and Personal Data Pac are hard to beat. The system ranks as the fastest removable-mass-storage system and among the least expensive. Though flexible-cartridge systems are the most able to take a beating, the Personal Data Pac's rugged construction makes it a safe choice among removable hard disk subsystems.—Mitt Jones

TRADEWINDS PERIPHERALS INC. Traveldisk 10 (Model 1) Traveldisk 22 (Model 2)

Late last year, Tradewinds Peripherals became the first manufacturer to produce a truly portable, external hard disk—the Traveldisk—thereby simplifying the tasks of transferring, securing, and backing up your data. Although the Traveldisk currently faces competition from similar units, such as Aristotle Industries' Plato thardqua: 20 Jaiso reviewed in this issue] as well as other types of removable hard disks and cartridges, it still earns high marks for its durability and portability.

The models we received for testing included the Travelskist 22 (Model 22, which is priced at 5615, and the Travelskist (Model 1), which best lors 63500. The necessary cabling and bus extender card and the control of the control of the control of the models are sold in 10, 22, 32, 40, 49, or 100MB versions, which range in cost from 3590 to 52,065 to including bus cards or cables). This wide range of storage capacities should meet the data backup needs of most users. To make backup even easier, the units come with Table II backup softtie units come with Table II backup soft-

The Model 1 units are pocketsize, weighing in at 3 pounds 2 ounces and measuring 2.6 by 4.15 by 5.9 inches (HWD). At 4 pounds, 2 ounces, and 3.5 by 5 by 7



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Traveldisk 10 Model 1)
List Price S390; bus extender card, \$50; cables, \$65; vinyl carrying case, \$20.
Requires: BBM PC, XT, AT, or compatible:
DOS 3.2 or later.

Traveldisk 22 (Model 2)
List Price: \$615; bus extender card, \$50; cables, \$65; viny carrying case, \$20.
Requires: IBM PC, XT, AT, or compatible;
DOS 3.2 or later.
In Short: The Traveldisks are distinguished
by their ability to withstand major shocks.
They re also small enough to easily trans-

They re also small enough to be easily that ported and are available in a wide range of storage capacities that can suit almost anyone's backup needs.

CHOLE BUT ON READER SHACE CAND inches (HWD), the Model 2 units are somewhat heftice—but still not big enough to make transporting them an awkward or strength of the still the still the still the case for the disks. Like the Plato Hardpac 20, the small size of the units also makes them ideal for fulfilling data security needs—simply unbook them from your

system and lock them away in a safe place. A Winchester drive and a drive controller board are packaged together and shockmounted inside each Traveldisk's solid metal case. The drives use a standard ST. 506 interface, and an MFM coding scheme. While the two 39'-in-by platters in the 10MB model are coated with a traditional oxide covering, the disks in units with capacities of 20MB or more are covered with the newer and tougher thin film.

The Traveklisk is shipped with both a low- and high-level format. You'll just need to copy your DOS software to the disk. The company warns that you may receive an error message if you are using certain early versions of DOS 3.1 and 3.2. To correct this problem, Tradewinds has included DOS 3.1 and 3.2 disks, which modify one of your hidden-system files when you reboot with them.

If you should need to reformat the Traedisk, the manual instructs you to disconnect any existing hard disk drives first in order to avoid accidentally formatting them. Reformatting is a relatively simple procedure, requiring that you first use the DOS DEBUG command. The rest of the procedure is uncomplicated: partition your disk using FDISK, and then format it using the DOS FURMAT command.

Unfortunately, the manual we received made this procedure unnecessarily confusing. Though the manual was clearly labeled as "preliminary," the company has been shipping Traveldisks for some months now.

The power (20 watts peak, 12 watts arrange) is supplied to the Traveldisk by means of a half-length bus card that installs in PCs, XTs, ATs, and PS2 (Models 25 and 30. The bus cards' design is clean and simple, unmarked by any jumpers or EPROM chips. A thick, 3-foot cable consens the Model 2 drive to the eards' the Model 1 is connected via a 2-foot-long shielded cable.

AUTOMATIC CONFIGURING
Once connected to a system, the Traveldisks automatically configure themselves as drive D: in systems with cose land disk is present, and as drive D: in systems with cose land disk in the control of the second dive, thereby making it in accessible. The company plans to introduce a device drive to override this limitation.

tion sometime later this year. While both units are similar in that they lack activity indicator lights, the Model 2 locan, scaled casing contrasts with the Model 1's outout design. The open design are built to account of the model of the contrast with the model as portable unit that which wanted a portable unit that could also fit directly inside PCs., XTs, and the could also fit directly inside PCs., XTs, and the model with the Model 1's with the Model 1's unit that is unit to the Model I with the Model 3, a unit that is under development. It will Entant a 4-inch connector and will interface to the buse card by means of a pencil-thin cable.)

Both units use a direct-drive rack-andpinion linear actuator mechanism: a high current is applied to the stepper motor to hold the heads over the track. (Both the Model 1 and Model 2 10MB units use a stepper motor that is different from the one found in units with larger capacities, which accounts for their noisier performance.) Although this mechanism makes the unit slower than those which use voicecoil actuators, it has the advantage of being four or five times more rugged. This allows the Traveldisks to withstand nerveshattering shocks and vibrations. Tradewinds claims that this makes autoparking unnecessary as well.

TAKES LICKING UNSCATHED When by to the test, the units proved themselve to be sturdy performers; they emerged from numerous businiss—such as indicated while in operation—unscated. They even managed anon—unscated. They even managed cliestly dropped 29% feet to the ground. While the drives proved themselves sipprenely capable of taking a licking when yet were quite fragile in one respect, uppliquing a Traveldisk from the system while

the computer is on could have fatal consequences on the drive controller and your

The PC Labs benchmark tests also showed the units to be reliable, midlevel

 Tradewinds' units proved themselves to be sturdy performers,

emerging from numerous bruisings unscathed.

performers. The 22MB Traveldisk is especially noteworthy: it rated as the fastest of the three truly portable external hard disk units we tested.

Most people will never need to bring their data with them while climbing Mt. Everest or tecking through tropical rain forests, but I wouldn't hesitate to recommend this unit to those who do. It's a rugged little performer that seems ready and able to take on the sings and arrows of outrageous fortune, or even airport baggage shandlers. That alone could make the Traveldisks worth your investment.

Lenaifer Zafon

WESTERN-DYNEX CORP. Datamodule

Western-Dynex Corp.'s Datamodule won't wow you with flashy features or

bowl you over with speed, but its budget price and solid performance may make it an attractive choice for limited applications.

The Datamodule system comprises a controller, an external drive housing, and either of two sizes of Datamodules: 20MB or 32MB. Total price for a 32MB system is \$695, well under the price required to get started with most of the other systems reviewed here.

You couldn't get much more basic than the Datamodule when it comes to removable storage. The removable disk unit includes the band-stepper mechanism and two imbedded servo platters in a 2.4pound package that slides manually into and out of the housing. An indicator light rests on the front panel of the removable disk

The housing itself is nothing more than a thin plastic case with a connector mounted on the rear inside panel. To keep the housing from sliding around on your desktop, you'll need to anchor it to your system chassis or desk with the adhesive velcro strips that Westem-Dynes supplies.

and your systems of prophysics and a processing of the control of



Datamodule Western-Dynex Corp. 3536 W. Osborn Rd. Phoenix, AZ 85019 (602) 269-6401

(602) 200-6401 Lat Price: Datamodule bir with 32MB disk, \$695; Datamodule bir with 20MB disk, \$595; Datamodule stell, \$540; Datamodule stell, Datamodule stell, \$540; Datamodule stell, old receiver kir with 20MB disk, \$580; Datamodule stell, \$580; Datamodule stell, \$580; Requires, IBM PC, YT, AT, or compuble or \$52 Model 30; DOS 2, or batte. In Short: A low-cost, no-fifsi semovable and disk system a 32MB and 20MB capacites, the Datamodule performs well under normal condisions, but is to ke of mormatic

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will be the C: or D: drive. If you're already running two hard disk drives in your system, you're out of luck; the Datamodule doesn't include the necessary drivers to be attached as a third drive.

Western-Dynex includes two backup utilities with the Datamodule: a menudriven version and a command-line version. Both allow backup of files by file specification using wildcard characters or

by groups of subdirectories.
Our 32MB evaluation unit performed well and without a glitch during PC Labs testing. The imbedded servo control gave it a respectable, if not glamorous, 63-milli-

second random access time. Its throughput figures were the slowest of the removable hard disk products tested, but still not bad for a removable-mass-storage system.

to a tremovator-mass-storage system. Serious limitations make the Datamodule an unwise choice for some removable-storage applications, however. One such limitation is the shock mounting of the disk steef. The disks are rated for a nonoperating shock of only 50g along each sait. We subjected our unit to more-serious shocks than it would suffer under noral use, and the unit showed no signs of failure. But one severe drop could well render the disk useless. Worse still, the 50g rating assumes that heads are parked in their landing zone, but the system makes no provisions for automatic head-parking or locking. Before you remove a disk, you'll have to remember to run the head-parking routine that Western-Dynex includes. Human memory being what it is, you're asking for trouble if you buy a removable hard disk that doesn't automatically park its heads.

If low price is a must and you're confident that you can treat a removable disk with great care, the Western-Dynex Datamodule may give you years of inexpensive service. The Datamodule also makes sense as a fast, low-cost alternative to slow, un-

executable tape backups.
For most removable-media applications, however, the Datamodule's low
shock tolerance and manually parking
heads make it a risky way of safeguarding
or transporting your valuable data. If durability is a must, look elsewhere.
—Mitt Jones



- Ad Pac
- Bernoulli Box II
 Passport

lomega Corp.'s Bernoulli Box II takes Editor's Choice for its timeproven dependability and the shock resistance of its flexible-media cartridges. If you plan to send disks through the mail, the Bernoulli Box II is by far the wisest choice.

Though the initial cost of the Bernoulli Box is not trivial, the system becomes inexpensive compared with removable hard disks if your application calls for multiple removable units. The disadvantages of the Bernoulli system are its unavoidable media wear and its lackbuster

speed.
Two newcomers to the removable-mass-storage market—Plus Development Corp.'s Passport and Tandon Corp.'s Ad Pac—also earn an Editor's Choice selection.

The Passport is expensive any way you look at it. Whether you buy only one removable disk or several, you'll pay more than you would for attractive alternatives. But Plus Development's fast and time-proven technology—the same that went into the HardCard 20 and HardCard
40—makes the Passport on excel-

lent choice when money is no object. Besides substantial shock protection, the Passport boasts true automatic park and lock to avoid head crashes. A board-three selection switch on the rear of the removable drive lets you override your system? usual boot drive—a real advantage if you'r er typing to toggle between OSS2 and DOS on the same system. All in all, the Passport exemplifies

thoughtful and competent design. Tandon's Ad Pac vielded the greatest throughput speed of the 13 removable-mass-storage systems we reviewed. It also handled severe punishment better than did the other removable Winchester products. Best of all, its 30MB Personal Data Pacs retail at about half the price of the \$795 40MB Passport. Our only major complaint with this system was its failure to prevent head crashes when power to the system was shut off. Though it actually lifts and locks the heads away from the platters before ejecting a disk, the Ad Pac does not retract the heads when you shut off power or during accidental power loss.

REMOVABLE HARD CARTRIDGES

SYQUEST TECHNOLOGY SVOuest SO555

If you're in the market for a removablemedia drive with large-capacity carridges, fast speeds, and a low price, the SyQuest SQ555 may be your best bet. But there's trouble in paradise: you'll have to sacrifice DOS versions 3.1 and 3.2 if one was your version of choice, and if you intend to carry your cartridges around, you may have to intoce.

SyQuest's SQ555 is an internal halfheight Winchester hard disk drive that sells for \$995. Cartridges are slim, measure just over 5¼ inches square and are housed in a transparent brown plastic case. At only \$100 each, these 44MB (formatted capacity) disks are quite a bargain.

That is, if you're careful with them. The PC Labs "drop test" had fatal consequences for the SQ555 cartridge. When I powered up the disk after a 2-foot drop, horrendous groating notices emanated from the drive, and the disk malfunctioned. SQQuest explained that the disk's plastic case is held together by only six pins, although the company is exploring



SyQuest SQSSS SyQuest Technology 47923 Warm Springs Bivd. Fremon, CA 94538 (41) Proc. 5905: catridge, \$100. Requires: IBM PC, XT, AT, or compatible; DOS 3.3 or later for the SyQuest SQSSS delivers a lot or performance for a little cash. The driver's

only major drawback is the fragility of its cartridges; only one fail to the floor can put a disk out of commission. The SQSSS tisseds ow well on PC Labs benchmark tests that users who don't need to pass disks from hand to hand may find it the best drive for their mass storage dollar.

other constructions to improve shock resistance. Considering that the idea behind removable hard disk cartridges is that they're mobile, the fragility of these disks could be a considerable deriment.

CONSISTENTLY SPEEDY If the cost of speed is low shock tolerance, it may be worth paying. The SQ555 scored consistently among the top three or four competitors on all of our benchmark tests, coming in first for the Disk Access Sector Read

test. From start to finish, installation couldn't be easier: Attach guide rails to the drive to slide it into any drive bay; SyQuest recommends the B: drive bay. Connect the drive to its half-size SCSI interface card with a 50-pin connector. Then attach the ground lug connector to the chassis of the computer, hook up the internal power cable, and you're ready to format. Since the cartridges come with a low-level format.

you need only partition the disk with FDISK and perform a DOS format.

I had no luck formatting the SO555 the first time I tried. Although the SO555 had been shipping for 6 months at the time of this review, the documentation was still "preliminary" and made no mention of the SQ555's requirement for DOS 3.3. We were unable to format the disk using DOS 3.2, and, when we discussed the problem with SyQuest, the company responded by sending us a field bulletin explaining the special partitioning procedure necessary to run the disk under DOS 3.1 and 3.2. Sy-Quest strongly recommends the use of DOS 3.3 to take full advantage of their disk's 44MB size. Thus the benchmark tests were run using DOS 3.3 instead of our standard DOS 3.2.

If you want to swap disks during a session, the only other task to perform is to install SyQuest's driver. SyQuest supplies other utilities that allow you to forms third and fourth physical drives, reassign drive numbers, and allow for an SCSI format. The security-minded will benefit from a utility that locks and releases the door of the drive at your command.

Although a power interruption will

If the cost of speed is low shock tolerance, it may be worth paying. The SQ555 scored high on all our benchmark tests.

cause the heads to land on the disk, Sy-Quest insists that its disks' construction prevents damage. The disk is standard plated media—a metalle add sk coated with spottered graphie material—but with a flaorocarbon lubricant. It is the tubricant that leeps crashed disk heads from affecting data, even if you errows the disk. Sy-Coest recommends waiting 30 seconds before ejecting the disk after a power-out and promises indefinite disk life crash after tures. The disk cartridge is equipped with a write-protect switch that you can enable by turning it with a screwdriver or even a dime. Both a power light and an activity indicator tell you what your drive is up to, and you can purchase a cleaning cartridge

to keep the drive motor hub dirt-free.

If you insist on removable hard cartridges that will survive customs inspections and overnight-mail packages, you
should probably look elsewhere. But if
speed, security, and cost efficiency are
high on your list of must-haves, the SyQuest SQS55 just fills the bill.

-Stephanic K. Losee

SYSGEN INC.

External DuraPak

Sysgen's DuraPak wins points for the astounding abuse-proof quality of the drive's removable hard disk cartridges, called DuraDisks. Unfortunately, durability comes at a price, and in this case the price is speed.

is speed.

The DuraPak product trio includes two internal drive units, single and dual, and a dual-external drive init. The single internal drive is installed in the 5t drive bay, the dual takes the place of both A: and B: floppy disk drives. We tested the single internal and dual-external DuraPaks only.

The DuraPaks are Winchester-type hard disk drives; they use 4-inch-square removable cartridges that resemble thick 3½-inch floppy disks. Each DuraDisk costs \$115 and has a formatted capacity of 15MB.

15MB. The DuraDisk hard disk cartridge includes a metallic disk coated with superhand sputered-graphite material, enclosed in a dust-free plastic case. The cartridges speral amout worry-free: the heads speral amout worry-free: the heads speral amout worry-free: the heads speral mines were proper failure, sham into the disk in case of power failure, sham into the disk in case of power failure, standing the speral power of the plastnet correctly positioned, so power must be restored to the disk before you can restore to the standing the disks in a clean environment, and the "Ill last almost indefinitely."

Sysgen reports shock resistance to 40g and really delivers. I dropped a DuraDisk cartridge onto a hard floor from 2 feet, 4 feet, and 6 feet with no change in perfor-

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mance. Then I threw it against a wall for further entertainment and watched in awe as it powered up yet again with no problems.

EXPLICIT DOCUMENTATION The

installation of both the internal and external models is straightforward, made even simpler by an explicit and well-written manual. The manual documents the hardware installation procedure so thoroughly that it even includes a chapter about removing and replacing the computer cover.

drive bay with guide rails, just as you would install a floppy disk drive. The dual external unit, weighing in at 141/2 pounds, is flat and sturdy enough to place between your monitor and CPU. Both DuraPaks hook up to full-length ST-506 controller boards. The internal unit is connected to the controller with 34-pin and 20-pin interface cables that come with the unit. Once the drive's power cables are hooked up to the floppy disk drive above and to the power harness, you're ready to go. The external unit stands alone and thus connects to the controller with a 37-pin interface cable from the outside. Plug in the 110-volt power cable, and hardware installation is complete.

Software installation isn't quite as painless as hardware installation. The fact that cartridges come pre-formatted doesn't seem to make life any easier. After the complicated process of making a working copy of the DuraPak Utilities diskette, you run the install program to make your Dura-

Pak cartridge bootable. The install program gives you the option of formatting, appends the SYSGEN.SYS file to the existing CONFIG.SYS file, and offers you the option of using Sysgen's utilities. The utilities include a partitioning program, a high-speed copy program, disk caching,



■ REMOVABLE MASS STORAGE

and diagnostic routines.

The Sysgen Optimizer program runs a performance test on the DuraDisk to determine the most efficient interleave for your system. Although the Optimizer will set an interleave factor on its own, the program allows you to review the performance results and reset the interleave at your discretion. XT users may find this customizing feature especially advantageous for their slower systems.

UNIQUE DURACACHE The DuraPaks are the only drives we tested that included a disk-caching program, and the sluggish times the drives clocked certainly transform that feature from a luxury to a necessity. While both the internal and external units tested at or near the bottom in all our tests, with the DuraCache option the times improved from 40 to 300 percent, moving the units to the middle of the pack. If you've got the extra memory, by all means take advantage of the DuraCache option.

You can boot from the DuraPak drives or use them in conjunction with an existing internal hard disk. The units will automatically configure as C; or D; (and up), de-

 Sysgen's DuraPaks are the only drives we tested that include a disk-

caching program.

pending on whether an internal hard disk drive is present. The use of a dual-internal and dual-external DuraPak at once will result in an assignment of C: and E: for the internal drives and D: and F: for the external drives.

Both units sport activity indicators whose red flicker you should get used to watching; the hard cartridges need time both to get up to speed and to slow down when you want to eject a disk.

The single internal drive unit, which is priced at \$1,495, may not pinch too much. but the dual-external unit's \$2,495 price tag may make the advantage of having a second drive simply not worth spending the extra bucks. Aside from the drives' initial purchase cost, the \$115 DuraDisk cartridge price is a good value not only in terms of dollar-per-meg but in terms of both disk life and durability.

Sysgen's DuraPak is a particularly attractive choice for uses such as backup and security where speed doesn't play such an important role. And if you have a 3-yearold who likes to go rooting around in your briefcase for toys to play with, you might give the DuraDisks a look, too.

-Stephanie K. Losee

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Volume 7 Number 15 September 13,1988

BASICA 3.x Program Control Statements

subroutine.

CALL — Call a machine language subroutine SYNTAX: CALL offset[(variable [, variable]...)] offset — offset of subroutine. Before using CALL

you must set offset to the correct value, e.g., offset = 0. variable - argument to the machine language

CHAIN - Transfer execution to another program SYNTAX: CHAIN [MERGE] Mename [.[Ine] [.[ALL]

[.DELETE range]] MERGE — if present, causes new program to be MERGEd with old (see MERGE command)

filename — program to transfer control to fine — specifies line at which new program starts. Default first line. ALL — says all current variables are passed to new program. If omitted, program must include a COMMON

nent specifying which variables are pa DELETE - acts like the DELETE command -

deletes a range of lines before MERGEing new lines COMMON - List variables passed to chain program

SYNTAX: COMMON variable [, variable]...

END - End program, close files, return to BASIC command level SYNTAX: END

FOR and NEXT - Perform a loop a given number of times SYNTAX: FOR numvar = x TO y [STEP z] ... NEXT (number [.number2]]...

numvar — an integer or single-precision variable x — initial value of counter

y - final value of counter z-increment

NOTE: A NEXT statement always matches the most recent FOR statement unless you follow it with a specific counter variable or variables.

GOSUB and RETURN - Branch to and return from a

SYNTAX: GOSUB line ... RETURN line - first line in the subroutine

GOTO - Unconditional branch to a given line SYNTAX: GOTO line

NOTE: If line is not executable, control goes to next executable line.

IF — Conditional branching instruction SYNTAX: IF number [,] THEN clause [ELSE clause] —or— IF number [,] GOTO line [], [ELSE clause] number - value 0 means FALSE, any nonzero value

means TRUE clause - (1) any BASIC statement, (2) a series of ments separated by colons, (3) line number to branch to

fine — line number to branch to NOTE: IF..THEN..ELSE statement must occur on a single program line.

ON...GOSUB - Branch depending on expression SYNTAX: ON n GOSUB line [, line] ...
n — GOSUB the subroutine start n—GOSUB the subroutine starting at the nth line in the list. If 0 or > 255, no GOSUR.

ON...GOTO — Branch depending on expression SYNTAX: ON n GOTO line [.fine]... n-GOTO the nth line in the list. If 0 or > 255, no GOTO.

RETURN - End subroutine and return to where it was

SYNTAX: RETURN (Inel line - optional line to return to. Normally

ited, in which case control returns to the calling location

STOP — Stop program without closing files SYNTAX: STOP WHILE and WEND - Execute a loop while a condition is

SYNTAX: WHILE numver ... WEND numver - loop repeats until numver becomes zero

Arguments for BASIC Statements

filename: A valid DOS filename preceded and optionally owed by a quotation mark ("). No wildcards. lenum: The file number with which the file or device was

lespec: A valid DOS file specification preceded and onally followed by a quotation mark (*). May include wildcard characters.

line: A program line number from 0 to 65535. Het: A list of numeric or string expressions for output, separated by commas, blanks, or semicolons. Separating with a comma causes the next item to be printed at the start of the next 14-character print zone. Separating with a semicolon or space causes it to be printed immediately after the last value. Unless a list ends with a comma, semicolon, or an SPC or TAB function, BASIC inserts a carriage return at the end of list. number: A numeric constant, variable, or expression

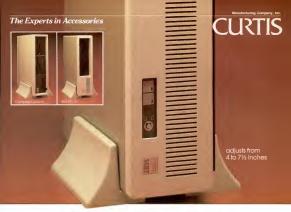
ever: A numeric variable (not a constant or expression). fiset: An offset from 0 to 65535 in the current segment. Set the current segment with DEF SEG. ON/OFF/STOP: event-trapping modes.

ON enables event trapping OFF disables trapping.

STOP disables trapping but remembers any activity so an immediate trap occurs at the next ON. string: A string constant, variable, or expression stringvar: A string variable (not a constant or expre

subline: A line number where an event-handing subrou-tine begins. If 0, disables trapping that event. ariable: Any numeric or string variable

-Nell J. Rubenking



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PRODUCTIVITY

■ PC LAB NOTES: C LANGUAGE ■ RICHARD HALE SHAW

WRITING OPTIMAL C: PART 2

Having considered size optimization in Part 1, this concluding article gives you practical tips and techniques you can use to make your C programs run faster.

In Part 1 of this series, 1 argued the benefits of optimizing your C programs and discussed a number of size optimization techniques. Unfortunately, the variety of factors that affect code size make this kind of optimization a somewhat abstract, even vague subject. Optimizing for speed, the subject of this concluding article, is a more precise topic, involving specific gambits and techniques.

specific gambits and techniques.
I'll begin with an overview of speed optimization, some methods of measuring
execution time, and a look at the efficiency
of C's control structures. Then I'll follow
with a number of techniques that you can
begin to use right away. As in Part I, I'll
assume you are using either Version 5.x of
Microsoft Cor Turbo C 1.5.

GETTING STARTED Experienced assembly language gurus, such as those who write PC Magazine's Utilities column, know that it's more efficient to set the AX register to 0 with the assembler instruction XOR AX, AX than with MOV AX, 0. The former takes fewer machine cycles.

In an effort to choose the most efficient means of accomplishing a task, assembly means of accomplishing a task, assembly language programmers often count the number of clock cycles used by each instruction. This kind of analysis is repeated by each instruction. This kind of analysis is repeated until, eventually, the instructions and cy-cle times become second nature. Thus, the experienced assembler programmer knows which instruction, or sequence of instructions, is more efficient.

I'm not advocating that you run right out, dump an assembly language listing of your C program to the printer, and begin to count clock cycles. But the principles involved are the same. A good approach to optimizing a program is to start at the top and work down. First, determine which part of your program needs optimization.

PRODUCTIVITY INDEX

PC LAB NOTES

More great optimizing techniques for speeding up your C programs.
UTILITIES
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USÉR-TO-USER
Consolidating batch files; deleting sensitive data files completely.
POWER USER
Rapid glossary entries in Microsoft

Word; SUM and COUNT in dBASE. LANGUAGES Convert Turbo Pascal reals from 6 to 8 bytes; OuickBASIC file copying.

PC TUTOR

Multitasking options for personal computers; forms of the RET opcode. CONNECTIVITY CLINIC Capture NetBIOS return codes and translate them into English. Next, study the algorithm used: would another algorithm do the job more efficiently and effectively? Finally, if the algorithm is right, how well has it been implemented? Only after you've answered these questions should you ask yourself whether one expression or instruction should be used in place of two.

For the C programmer, this often means that only a handful of functions—perhaps only one or two—will really need optimization. Study the algorithms used in these functions and determine whether the right choice's have been made. Is there a more efficient algorithm, or can the existing one be improved considerably? Remembering the axiom that "90 percent of program nutriue will be spent executing. 10 percent of the code," find the portion of your program bat needs

the most optimization. Once the algorithms you've chosen have been verified as correct, there are still a number of other optimizing opportunities available. For example, one option is to write assembler functions that can be called directly by the C program. A wellwritten assembler function can often improve the execution time of a C program. However, the decision whether or not to take this approach isn't always straightforward and depends on a number of mitigating factors. Most obvious, of course, is whether or not you are experienced with assembler. Another important consideration is portability. Since assembly language is intimately tied to the CPU architecture of the computer, programs (or portions of programs) written in assembler

PC LAB NOTES

are not portable to other CPU architectures. However, one reason that programmers write in C is because it is portable.

Assembly language is incredibly useful for writing certain types of programs, such as interrupt handlers and device drivers. And eounting clock cycles is often the most accurate means of estimating the performance of a section of code. But this is tedious. I'm not at all against programming in assembler-the thrill of controlline the computer at such a low level is a heady experience. However, writing funetions in assembler is only one way to im-

prove the performance of your code. Another option is to apply the concepts of eyele counting to C operators and function calls. In his book, Efficient C, Tom Plum defines two eoncepts that can be used to help estimate and measure the performance of a C program. The first of these is the Average C Operator (ACO), which is the average time required by an assortment of operations using short ints. The second is the Average Function Call (APC), which is the average time needed to call a function with a single argument and return to the caller.

An understanding of these concepts can help you estimate the performance of a section of eode in much the same way that counting machine cycles helps an assembler programmer. Time estimates for functions can be generated by multiplying the ACO by the number of operators in the function, multiplying the result by the number of executions of all of the operators, and then adding the AFC. Plum found that this yields an estimate that is accurate within 30 percent.

You'll find that taking the time to estimate performance pays off by giving you a better idea of where to introduce optimizations. You'll also find yourself using more-efficient code constructs when writing eode in the future. However, developing a skill for optimizing code comes with practice. Measure the performance of any piece of eode you suspect may be slow. The more code you test, the quicker you'll develop an eye for sighting slow code.

MEASURING EXECUTION TIME There are a number of ways to measure program and code performance, but a simple and effective approach is to write a

small test program that performs only the operation you want to use. Then time the program both with and without the operation included in the eode. The difference between the times is the real overhead of the operation. DIVTEST.C in Figure 1 is

efficiency of a single C operation. It can be modified to calculate the efficiency of a number of operations and expressions.

This same technique can be used to time whole functions and algorithms. To test a function in the context of a complete an example of a program that calculates the program, you can either time the function

```
/* divtest.c RMS 5/18/88
* This program reports the time to execute a loop with a long divide
* operation in it.
    To compile for MSC 5.x:
٠
          cl /W3 /Od divtest.c
#define ITERATIONS 100000L
#define DIVIDEND
                    1000L
#include<time.h>
#include<stdio.h>
woid main(woid);
                              /* function prototype */
void main(void)
     long i,start,end,temp;
    float loop, expr;
    start = clock();
    for( i = SL: i < ITERATIONS: i++) /* time the operation
          temp = (i/DIVIDEND):
                                        /* divide is tested here */
    end = clock();
    expr = (float)(end-etart);
    expr /= CLK TCK:
    printf;"\nLoop with Operation time = %84.84f seconds",expr);
    start = clock():
     for: i = $L; i < ITERATIONS; i++}; /* time the loop alone */
          temp = i:
    end = clock();
     loop = :float):end-start):
     loop /= CLK TCK;
    printf;"\nLoop
                                   time = %84.84f seconds",loop);
```

Figure 1: DIVTEST.C is a program that times the efficiency overhead of a long divide. It uses the Microsoft C clock() routine to calculate the CPU time used in seconds. You can modify it to test nearly any operation or expression. To generate the times, the divide is executed in a loop, and then the loop is timed without the divide. Remember that the times reported are for ITERATIONS' number of executions. Note that to get raw results, the program should be compiled with the /0d. switch, which turns off optimization by the compiler. This program is for Microsoft C, Version S.x. only. It does not work with Turbo C or QuickC.

= %#4.#4f seconds*,expr-loop);

printf:"\n\noperation overhead

itself, or time different versions of the program with different versions of the function included. TIMERUN.C in Figure 2 is a sample program that times the loading and execution of another program.

Both these programming examples use the ANSI clock() function, which makes them nortable to other environments, although the results are reported in seconds. Note that while accessing the system clock of your machine can improve timing accuracy, it should be used only under strict conditions. Be particularly wary of using the system clock when TSRs are loaded. If a TSR is activated by the keyboard alone, it can't hurt too much. But if a TSR steals the clock interrupt (as do Side-Kick and PRINT.COM), it will slow down the system and provide inaccurate results. Further, if you are running your program under OS/2 or Unix, be sure to terminate any other tasks before running the program

you want to test.

Dissecting the details of an algorithm (or whatever you are timing) will lead you to repeatedly accurate timings. Remote that the efficiency of an operation depends on three factors the operation to be performed, the type of object or operand on on three factors, the operation to be performed, the type of object or operand to lead to the operation of the oper

When timing a code section in a large model program, the storage class of the data used is important. External data may often be in another data segment when it's accessed. This will bring increased overhead, so it's important that you simulate this when writing timing programs. The same is true for external variables included in Dynamic Link Libraries (DLL) under OS/2.

One more tool for measuring the performance of a program should at least be mentioned: a profiler. Profilers measure how often each piece of code is executed in a program. I needn't discuss them, however, for my colleague, Neil J. Rubenking, has throughly discussed he benking, has throughly discussed with use in "Optimizing Turbo Pascal" (Pd. Magazine, Nowabre 24, 1987) and listed some program profilers that can be helpful to C programmers.

CONTROL STRUCTURES What impact do C's control structures have on the efficiency of your code? Obviously, the time expended in an £f and the completion tests in for. while, and do statements depend on the complexity of the expression being tested. And, of course, for statements carry the additional overhead of

any preceding and following statements. Switch statements are a different matter altogether, for here you're usually at the

/* timerun.c RHS 5/18/88

mercy of your compiler. A compiler can implement a switch in a variety of ways. First, if there are only a few cases, it may be implemented as a series of ifs with a few quick comparisons.

Second, if there are a large number of cases in a switch, a "jump table" might be created. This is a table containing a series of entries, one for each possible value between the highest and lowest values specified in your code. The switch value is

```
* This program times the load end execution time of emother program.
 · Return Velues set eres
    The return velue of the 'child' program, or
    255 if unsucessful.
* For MSC 5.x1
         cl /ox /W3 timerun.n
(include<time.h>
fincludeess.h>
includecatdin.h>
void main(int ergc, char **ergv);
void main(int ergo, cher **ergv)
     long stert = $L, end = $L;
     int retvel;
     if(ergc < 2)
         printf("\nUsege: timerum <program> (ergs...]");
         printf("\nPurpose: to report the run time of e program in seconds");
         exit(255):
     printf("\ntimerun: ettempting to run: %e...",argv[1]);
     argy++;
                                   /* set argy to point to ergy[1]
                                   /* the old ergv[1] is now ergv[8]
     start = clock():
                                   /* start the plock ...
                                   /* run the child
     if((retvel = spewnvp(P_WAIT,ergv(8),argv)) == -1)
          printf("\ntimerun: Child process feiled, eborting...");
          exit(255);
     end = clock():
                                   /* get clock efter return from child*/
     printf("\ntimerum: \"%s\" took %84.82f seconds to loed end execute".
         ergv[#], (floet) (end-etert) /CLK_TCK);
     exit(retvel);
                                   /* exit with return value of child .=/
```

Figure 2: This program times the loading and execution of o second program by calling the Clock () function before and after it is run. Note the use of the /Ox switch to achieve maximum optimization of the resulting executoble, TIMERUN.EXE. This program is for Microsoft C. Version 5.x. only. It does not work with Turbo C or OuickC.

■ PC LAB NOTES

The some of the state of the

used as an index into the table, and each entry points to code to "jump to" when that entry is accessed in the table.

Third, a set to h might be implemented as a table with two parts in each with other. The first part is a value with which the associed was sexified value is compared and the security of the sexification of the code to be executed. If the new toth value mandes the first markes there are the address pointed to by the second part in the similar to the jump table, the comparison of the part of a set the dependent of a sext tenth depends on its implementation by your comparison.

Unlike a switch, a function call is affected by two different timing factors: the

fixed overhead of the CALL and RET opcrations and the handling of arguments (which, of course, varies from function to function). Each of the arguments must be pushed onto the Stack, and the Stack must be cleaned up upon return.

You can't fine-time Library functions unless you have the source code for them or replace them with your own versions. It's more critical, however, to be concerned with how a function is used—purfucularly if it is called in an intern loop. If you're not concerned with size, the intrinsic (maxre, or it —line) versions of character some content of the content of the

digit() are examples of this phenomenon. For further discussion on intrinsics, see the section under the subhead "Intrinsics Versus Functions.") The low-level I/O functions, such as read(), write(), and Issek(), are faster than stream I/O functions like fread(), furtie(), and fseek(), which have more everytees.

Plum's research, conducted with a wide variety of processors, showed that while a switch is slightly more time-consuming than the average operation, a function call takes three to six times as long. Furthermore, while I/O functions tend to vary, functions like fgetc(), get-char(), functions like fgetc(), get-char(), functions like fgetc().

A POTPOURRI OF OPTIMIZATION TECHNIQUES

Included below are a number of optimization "'do's," maxims that you should follow. While each is a valuable idea for improving the performance of your code, they are especially important if you don't already have an optimizing compiler.

I. Become familiar with the assembly language output of your compiler. You don't have to program in assembler to learn how to use it to improve your programs. A good way to start is to become familiar with the machine code output of your compiler. You can generate assembly language listings from Turbo C with the S- option. Combining the /Fa /Fa options for Microsoft C will produce a "merced" C and assembler Isining.

2. Use switch() and case with optimizing compilers. Since the nature of a switch statement guarantees that a single integer type (character, integer, or long, under ANSI) will be evaluated, optimizing compilers can make a number of assumptions that will enable them to streamline the code. An added plus is that switches are far easier to read than a series of it—a like.

Use shifts instead of multiplies and divides, when possible. While some optimizing compilers might do this for you, it's generally good practice to shift right when dividing by a power of 2, or shift was the shift of the

left when multiplying by a power of 2. The rule of thumb is to shift once for every power of 2, so a divide by 4 and a multiply by 4 would be coded, respectively, as

x >> 2; x << 2:

 Avoid unnecessary loops, particularly when initializing an array. While a good optimizing compiler will replace the loop for you, it's still sloppy coding.

 Consider using high-quality commercial packages. Familiarize yourself with packages that, for a small outlay, may save you the time of writing and optimizing your own routines. Look for those that boast about their speed but also provide good support.

6. Learn to optimize loops. While trying to keep the loop tests as simple as possible, remove unnecessary function calls and extraneous calculations from the body of the loop itself. You don't have to make a loop terminate by executing the loop test; you can insert a break statement for a fast exit when the loop processing is complete.
7. The following are techniques specified.

cific to Microsoft C:

Force global variables into the default data segment to speed up access in large data models (see the discussion on mem-

ory models in Part 1). This can be done by initializing them when they are declared.

- Use the near and far keywords to specify data that should be placed in the default data segment for the large or compact models. Using the huge keyword will allow a huge array to be accessed from the small and medium models.
- from the small and medium models.

 Speed up frequent accesses to large objects by forcing them into their own data segments. You can do this by setting the data threshold—the maximum size of the default data segment. This will force objects that are too big to fit to be given their own data segments.
- Use the "same_seg" pragma to specify items that should belong in the same
- far segment.

 Use the /F command line switch to

 Otimize far calls to procedures that lie in
 the same segment as the caller (this is
 equivalent to specifying on support routines for a primary function such as
- Use the /PAC option to group neighboring code segments. Large code programs place the object code from each source module in a different segment by default. You can combine different modules into the same code segment, allowing their calls to be optimized as near calls.— Richard Hale Shar

How Farsighted Executives Are Using Their PC's For The Fun Of Profit.

By William J. Spink

For years now you've been hearing about the wonderful things personal com-

puters will do for The Executive of the 80's-at least in theory. But what's the reality? Can a PC

help you enjoy your work more and show a greater profit, here and now? According to your peers, the answer is "yes."
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need information like that," Lynch says, snapping his fingers. He recalls an example of how Dow Jones News/Retrieval®-the business and financial information service from Dow Jones & Company, Inc.-gave JCPenney Company a real advantage.

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■ PC LAB NOTES

usually the fastest across C compiler implementations. This should come as no surprise, since these are usually implemented as macros and thus become in-line code.

SPEED-IMPROVING TECHNIQUES It is impossible to present here every technique available for optimizing C, so I'll discuss only some of the more important

ones. Others are presented in the sidebar "A Potpouri of Optimization Techniques." Since quality optimization is inrecasingly found in today's PCMS-DOS C compilers, some of the ideas I'll present work in conjunction with a good optimizing compiler. A discussion of C compiler optimization is contained in the sidebar "Compiler Optimization: Terms and Techniques." A reference summary of compiler optimization switches for Turbo

C and Microsoft C is included in Figure 3; a look at optimization pragmas for Microsoft C can be found in Figure 4.

REGISTER VARIABLES Perhaps the most popular optimization technique available to C programmers is the use of the register keyword. Modifying the declaration of a variable with register, as shown in Figure 5, indicates to the compiler that the variable is to be placed and kept in the machine registers as much as possible.

Most 8086-family C compilers that support register usually keep up to two registers available for this purpose. For example, Microsoft C saves the contents of the DI and SI registers on the Stack upon entry to every function, uses them for any register variables, and restores them before exiting the function.

While you can specify any number of register variables, be careful not to overdo it. Optimizing compilers like Microsoft C generate code that places often-crossful C generate code that places often-crossful C generate to the code of the code of the places of the code of

ply this keyword only to variables that are accessed three or more times in a function.

In support of this, Reed Koch, Program Manager for Microsoft C.S. I, informs me that most of the time the 5.1 compiler can select regulater variables more effectively than most programmers, so be generally advises against using regulator energy advises against using regulator and programmers, and for the selection of the select

ister variables should improve the code when compiling with it.

Two future moes should be made on the subject of regist er variables. First, you can gain some size optimization by turning off register variable optimization when using Turho C. This is accomplished by using the -ro-option, which will ignore the occurrence of register in your code. Second, since the number of register variables are used to be recorded to the property of the control of the property of the prope

Compiler Optimization Switches: Turbo C and Microsoft C 5.1

Turbo C

urbo C

	Memory	Model	
	Option	Meaning	
	-mt	Tiny memory model	7
•	-ms	Small memory model	
	-mm	Medium memory model	
	-mc	Compact merrory model	
	-mi	Large memory model	

lotrary

d Caste one instance of derical
string constants

G Optimize for speed

N Turn ON stack checking

O Optimize for speed

Use Placed calling convention

I see the constant of the convention

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Turnible real stack with seed

Turnible real stack with seed

S Generals assertions rating

Microsoft C 5.1

CAS

AM

/AC

AH

940

ory Model

Meaning

Small memory model

Medium memory model

Compact memory model

Large memory model

Huge memory model

eous /Oa Relax alias checking /Od Disable cotimization for debugging DUTDOSES a Use intrinsic versions of functions a Turn ON loop optimization /On Disable unsafe loop optimizations n. Optimize for size n Optimize for speed Ox Turn ON max o leguisoleer to (Dait /Gs) Gs Turn OFF stack checking /Gc Use Pascal calling convention G. Set the data threshold · /G0 Generate 8086/8088 instructions Generate 80186/80188 instructions G2 Generate 80286 instructions

((inker option)

Segmentiation
Option Meering
Arthure Name the code segment
None Name the data segment

Optimize far calls (linker option)

Group neighboring code segments

Figure 3: This subset of the compiler switches available for both Microsoft C 5.1 and Turbo C 1.5 contains those that will be most useful for opinization. Consult your compiler manual for a more detailed explanation. Default options are marked with an *.



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Pragmas: The ANSI Way to Be Non-ANSI

_	
Pragma	Description
*pragma loop_opt(on off)	Turns loop optimization ON/OFF.
<pre>#pragma intrinsic(funcl,)</pre>	Turns ON use of intrinsics for the specified functions.
#pragma function(func1,)	Turns OFF use of intrinsics for the specified functions.
*pragma check_stack(on off)	Turns stack checking ON/OFF.
#pragma pack(n)	Packs structures to the rith byte boundary.
<pre>\$pragma alloc_text(segment, func1,)</pre>	Names the segment in which the functions are to be placed.
<pre>\$pragma same_seg(var1,)</pre>	Specifies variables that should be placed in the same data segment.

Pragmas are part of the result of the ANSI Committee's efforts to standardize the C language. Designed as preprocessor directives, pragmas provide a means by which an implementation (a C compiler, for example; can allow a program to include nonstandard behavior of nonpratible extensions. Consult your compiler manual for moredetailed information on pragmas supported by other compilers.

Figure 4: A partial listing of pragmas used for controlling optimization by Microsoft C.

ARRAYS OR POINTERS? It's common practice to use offsets when manipulating the contents of an array, particularly inside a loop. This requires a program to calculate the address of each element of the array by adding the offset of the element. times the element size, to the starting address of the array. But this takes time. You can accomplish this more efficiently by casting a pointer to the beginning of the array and manipulating the pointer instead. Again, it's slower to manipulate the members of complex or nested data structures than it is to cast a pointer to the member involved and manipulate it directly. These points are illustrated in Figure 7.

Far pointers (that is, 32-bit addresses) present a dilemma. I personally prefer using them when I need to access external data in small data-model programs. Moreover, far pointers are particularly useful to perform direct screen writes and manipulate BIOS data objects. Unfortunately,

register int i; register char *ip;

Figure 5: Two ways of declaring a variable to keep it in the machine registers, if available.

they're not always very efficient: the address arithmetic overhead can be heavy if they are used frequently or in a loop. If your timing tests show that the use of a far pointer is slowing down your program too much, write that section of the program in assembler so you can temporarily set the DS register to the data segment of your far pointer.

INTRINSICS VERSUS FUNCTIONS If you're willing to sacrifice some space, you can gain speed by using intrinsics or macro functions. Some of the low-level character routines (put char (), get-char (), get-char (), and others) have been implemented as macros since the earliest Commented as macros since the earliest Compilers. Yet some compilers offer both function and "intrinsic" versions of various library routines, as shown in Figure 8.

By using intrinsics, you're adding some

in-line code where the function is referenced, but you gain speed by climinating the actual function setup, call, and return. In fact, you may actually save space if the in-line code is smaller than the code used to to set up function arguments. The rule of of thumb, however, is that intrinsics are a few bytes longer but several times faster. Intrinsics are particularly effective when used in a time-critical loop. You can Memory Lane

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reduce the loop overhead by using intrinsics in place of function calls. Be careful, however, for some intrinsics may have limitations not found in their function counterparts: they just can't be written to be as seneral as a function.

If a routine requires intrinsics, place it critical functions smaller.

in its own source module and compile it separately from the rest of your code using the appropriate command-line switches (see Figure 3). This will isolate the use of intrinsics to those modules that need them, and keep the code size of other, less time-

Figure 6: This listing demonstrates how the use of preprocessor macros can help ensure that only the most important variables are placed in the machine registers. Regardless of their order, REGI and REG2 will always designate register variables, while REG3 will be ignored. REG3 can be

Figure T: Two code fragments that demonstrate the use of a pointer to initialize an array. In the first, the office into the arroy (1) must be calculated, to the pointer eliminate the calculation and a good compiler will place both i and p in machine registers. In the second fragment, the array is a member of a complex set of structures and pointers. Rather than calculate the address offset to the array each time, oponiter is set to the beginning of the array and increments.

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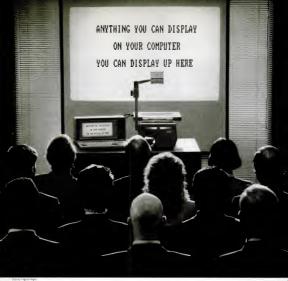
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REIAXED ALIAS CHECKING If your compiler's optimizer can turn off alias checking, you can achieve significant gains in efficiency. As explained in the "Compiler Optimization" sidebar, a compiler must assume by default that aliases exist. This keeps the optimizer from producine errors in the eenerated code.

When you are certain that you are not referencing the same memory location with more than one symbol in a function (and therefore producing an alias), you can

turn off alias checking. Combined with loop optimization, this will produce some significant gains in speed.

USING LOOK-UP TABLES While most veteran programmers are familiar with the benefits of look-up tables, the concept may be foreign to newcomers. And though they can take up space, look-up tables are a fast alternative to redundant calculations that are performed over a fixed range.

The classic ASCII-to-EBCDIC conversion program provides a simple example of a look-up table. EBCDIC, as you probably know, is the character set found on most IBM mainframes. A conversion program of this type utilizes a look-up table, which is usually an array of EBCDIC character values.

The values in the array are so arranged that each is stored at the array offset of its ASCII counterpart. An EBCDIC value for the letter A (193) is thus found at slot 65 in

COMPILER OPTIMIZATION: TERMS AND TECHNIQUES

Contemporary C compilers are gateting better and better at optimizing machine code. Often what we think of as "an optimizer" is actually a product of several parts of the compilation process, each of which plays are id. The following performed by a compiler about being you understand what a compiler can do, and how you can write code that the compiler can optimize more easily. I'm indebted to Reed Korch, the Program Manager for Mersond C-5.1, for his help in clarifying

Common subexpression climination If an expression is used more than once in the same function and its value doesn't change, then code is generated to execute the expression once. The result is placed in a register, which is used throughout the function.

Constant folding If constants are used in an arithmetical expression, the expression is replaced with the result of the expression. This is usually performed by the preprocessor.

Constant propagation if a constant value is assigned to a variable and does not change for the life of the variable, then references to the variable are replaced with the constant. The variable is omitted altogether.

Cross jump elimination If more than one instance of the same piece of code occurs in the cases of a switch or in several if statements, then one instance is placed where all of them can jump to it.

Extra jump elimination If code generation produces a jump to a jump, the first jump is set to the destination of the second jump. If it is unused, the second jump is removed.

Instruction alignment If the generated code produces a jump to an uneven address, a NOP instruction is inserted at the destination. This forced alignment causes all jumps to end on even address boundaries, which are more efficient to process and can result in a 10

percent gain in speed.

Loop induction variables If a variable is frequently referenced in a loop, a register or a stack variable is set up to contain it. This also contributes to loop strength reduction optimization (discussed below), particularly with frequently referenced array offsets.

Loop invariant code motion If the same piece of code is continually executed within a loop, the code is moved out of the loop, where it will be executed only once, before the loop begins.

Loop optimization (special cases)
If a loop is used to initialize a portion of
memory, the compiler substitutes a processor instruction such as REP STOS to
perform the initialization in one step.

Loop strength reduction This is the process of removing unnecessary overhead from a loop. Such a procedure might include the optimization of loop counters, such as those that are also used as an index into an array. Strength reduction might also include replacing multi-olications with iterative additions in the

control line of the loop.

Loop unrolling A technique that obplicates the statements executed in the loop in order to reduce a potentially large number of loop iterations to half. This is more common in mainframe environents, where it may take less time to execute duplicate instructions that already exist in the processor's prefetch instruction queue than to retrieve them from memory each time through the loop.

Peephole optimization This is the process of taking small pieces or windows of code and optimizing the use of registers and variables, etc.

Relaxed allias checking An allias is more than one symbolic reference to the same memory location in a program. A compiler must take care in handling aliases, since one alias (and thus the value of the memory location referenced) may be in a register while another may on! If alias checking is relaxed, the compiler can assume that there is no more than one active reference to the same man one active reference to the same man of the control of all the control of the co

Tall merging If a jump is generated, whose destination is a return (RET) instruction, the jump is replaced with a RET instruction itself.

Tail recursion optimization If a function ends with a recursive call to itself, followed by a return, the compiler generates a jump to the beginning of the function code in place of the recursive call.—Richard Hale Shaw

■ PC LAB NOTES

the array, 65 being the value of A in AS-CII. So to convert an ASCII character to EBCDIC, you see the value of the ASCII character as an offset into the array, and the corresponding value in EBCDIC is stored at that offset. Thus it can be 'looked up' in the array or table. Figure 9 illustrates an array declaration and a macrothat can do the whole; job. Keep in mind, though, that look-up tables require a tradeoff of space for speed.

REMOVING STACK PROBES Many compilers provide automatic stack checking, ensuring a function call and its local variables do not extend beyond the end the Stack (possibly overwring Heap variables or globals). A compiler engineers this by inserting calls to an internal function (usually called _chkstk(), or the like) at the beginning of each function. If

```
C Functions
MS-DOS interface
 _enable
               disable
Console and port I/O
 ino
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 outpw
Butter ma
              memcov
String manip
 strset
 strcat
 _rot
                            Irat!
              min
 _lrotr
                            max
 abs
Math
 acos
              asin
 atan2
              ന്ദ
                            cosh
 exp
              fabs
                            fmod
              log10
                            DOW
 loa
 sin
              sinh
                            sart
```

Figure 8: The functions shown here all have intrinsic counterparts in the Microsoft C 5.1 Library.

Figure 9: A code fragment that demonstrates a look-up table used to convert ASCII to EBCDIC. The Sot loop converts and prints the conversion values of the first ten letters of the alphabet. Notice that, implemented as a macro or a function, each conversion is fast since it involves only one "hit" or look-up. The array uses ints for speed, although this takes up more space.

the stack-checking function detects a Stack overrun, the program is aborted and an error message is printed. This allows you to test a program and detect the problem before the program becomes heavily used.

While the stack checks (or stack probes, as they are sometimes called) do take a small amount of space in your program, they significantly increase the speed of a program with repeated function calls. You can remove the stack probes from your program by compiling with the appropriate command-line parameters or pragmass (see Figure 3). However, this should be done only when the program is steed, debugged, and ready to ship.

EFFICIENT DATA TYPES Another technique for improving program execution speed involves your choice of efficient data types. Take a look at all of your references to Longs. Do they fall in the range of ints (or unsigneds), and can they therefore be replaced?

In Part 1, I mentioned that using bitmaps can save space. However, the overhead of calculating bit offsets and manipulating the bits themselves is greater than toggling the value of a byte or word (a char or short int). As a result, the space savings is offset by the increase in execution time.

SPEEDING UP BY COUNTING DOWN Loops that count down to 0 from a value are generally faster than those that count up, because instructions that compare a value to 0 require fewer cycles than those that perform a general comparison.

CALLING CONVENTIONS The calling convention used in your functions is another way you can both reduce size and increase speed in a C program. The Standard C calling convention for 8086 C compilers

· Choosing efficient data

types is another technique for improving program

execution speed.

requires that arguments be pushed onto the Stack in reverse order; that is, the last argument is pushed first and the first argument is pushed last. In addition, the caller is responsible for adjusting the Stack upon return. This process is the same for every function call.

An alternative is to use the "Pascal"





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PC LAB NOTES

calling convention, so-called because it was first widely used by Pascal compilers. Under this convention, arguments are pushed onto the Stack from left to right. More important, the called function removes the arguments from the Stack. Since most programs have fewer functions than function calls, this results in significantly smaller code overall and in faster execution of function calls.

Compilers that offer this option (including Microsoft C) usually let you set a command-line switch so that all compiles generate Pascal calls (see Figure 3). In addition, Microsoft C offers the pascal

 When optimizing code. observe Tom Plum's caveat: "Make it right before you make it fast."

keyword to specify Pascal function calls. You can always use the command-line switch and use the cdec1 keyword to specify the standard calling convention for a function, bearing in mind that functions which use a variable number of arguments must be called with the standard C calling convention.

ROUTINES "NEAR" AND "FAR" From John Hile, the engineer behind the communications program HyperAccess. comes a valuable tip for working with a large (or medium) code memory model. If you have a number of support routines that are called only by a primary function, you should collect them all into a single module. Then declare each of the support routines to be near (be sure to update their function prototypes). The primary routine will still be far by default, but designating the support routines as near calls will provide a small improvement in both time and size.

OPTIMIZATION LIMITS Refore jumping in to optimize your code, always observe Tom Plum's caveat: "Make it right before you make it fast." Never sacrifice the correctness of the code for speed. Only when a program performs accurately should you begin to refine it into more-efficient code. What's involved is not only the efficiency of the program itself, but the

efficiency (and value) of the time you spend modifying and optimizing it.

Richard Hale Shaw is a contributing editor of PC Magazine.

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Making your own screen fonts



Changing the character set of an EGA or VGA used to require a programmer's skills. Now FONTEDIT makes it easy for any user to modify, create, and load his own screen fonts.

The text characters displayed by the | when you run it once. Both FONT- | As shown in Figure 1, the focal point

The text characters displayed by the original PC were frozen in the silicon ROM of its monochrome or color/graphics display adapter. The introduction of the EGA (and more recently the VGA) changed that. These newer adapters, besides offering more colors and better resolution, load the default text font from ROM into video RAM, where a program can get at and modify any or all of the characters. Programs that display 43 lines on the EGA take advantage of this facility, but it has remained largely inaccessible to the average user. Until now you've really had to be a programmer to modify the fonts in RAM

Not anymore. FONTEDIT, this issue's utility program, lets anyone with an EGA or VGA customize or create screen fonts to taste. As you toggle the pixels that make up a character on and off (using either your keyboard or a mouse), you see the results not only in a large Edit window but also in screen size, together with the other characters in that font. A large Template window shows you the original character, and if you mess up a modification hopelessly, a single keystroke will restore the original. Another keystroke saves your results and turns your modified font into a .COM file that you can load from the DOS prompt any time you want.

You can download your own copy of FONTEDIT.COM from PC MagNet, as described in the sidebar "FONTEDIT by Modem." PC MagNet also carries the source code, FONTEDIT.ASM, and a BASIC program, FONTEDIT.BAS, that will create FONTEDIT.COM for you

EDIT.ASM and FONTEDIT.BAS are also printed here, if you'd rather enter either at your keyboard.

The full syntax for FONTEDIT is

[d: [[path|FONTEDIT [filespec]] where filespec is the name (and path, if

needed) of a file in which you have stored a modified font. If you don't include a filespec, FONTEDIT uses the current font on the screen and, later, gives you an opportunity to save the font to a file. The only requirement for using FONTEDIT is an EEGA or VGA disolay adapter.

As shown in Figure 1, the focal point of the FONTEDT display is an Edit Char window that expands the character box to make the individual pixels visible. To its left is a similar-sized Template Char window that retains the original pixel map of the character you are editing. By default, the Edit window is 8 pixels wide by either 14 (for an EGA font) or 16 (for a VGA front) pixels high. When FONTEDT first

toning pixels light. When FOREIT lifts comes up, a capital A appears in the Edit window. The highlighted pixel in the top-left-hand corner shows the position of the editing cursor. You can move the editing cursor either

| Internal | 1 to | Column | Artification | Column | Column | Column | Artification | Column | Column

Figure 1: When FONTEDIT is first run, a capital A appears in the center edit window with the pixel cursor in the top-left-hand corner of the window.

UTILITIES

with the four Arrow keys or with a mouse. Pressing the Spacebar on your keyboard toggles the pixel under the cursor on or off: with a mouse you use the left button for on and the right button for off. FONTEDIT implements cursor wrap at the edges, so if you go off the right-hand side of a window, you'll end up back on the left. The same applies for the top and bottom. You can save extra key or button presses by "dragging" the current highlighted pixel value (on or off) to adjacent pixels. Just hold down either of the keyboard Shift keys while using the Arrow keys or hold down a mouse button and then move the CHESOF

Directly above the Edit window, the current character and its ASCII number appear in normal screen size. When you change a pixel in the Edit Char window, the change will be reflected both here and at all other places on the screen where that character appears in normal size.

The Character Set select window to the right of the edit window serves two purposes. First, by displaying all 256 possible characters in one place, it lets you see the results of your customizing on the font as a whole. Second, you can choose a new character to edit by highlighting one of those in the select window and then pressing Enter or either mouse button. The Tah key toggles you between the Edit window and the Character Set windows. Dragging across the character set (by holding a Shift key or mouse button) will load each of the highlighted characters as you move around. Once a new character is selected, pressing the Tab key once again takes you back to the Edit window.

You don't need to visit the Character Set window to select a new character to edit, however. With the normal ASCII alphanumeric character set (plus the Backspace key), you can simply press the desired character on the keyboard. The ASCII characters below the space (ASCII 32) and the high-bit characters (the international characters and line-drawing characters with ASCII codes of 128 and above) can be entered by using the Alt key in combination with the numeric keypad. Hold down the Alt key and type in the decimal ASCII code desired, using the numbers that are on the keypad (the numbers on the top row of the keyboard won't work). Af-

ter you type in the number, release the Alt key and the corresponding character will be selected.

Another convenient way to select characters for editing is to use the PgUp and PgDn keys. PgUp goes to the previous character and PgDn to the next character in ASCII order. For example, if D is the current character in the edit window, pressing PgDn will switch to character E.

FONTEDIT FUNCTION KEYS
PONTEDITA bonnakes used the first five
function keys. F1 deletes the current curperson two throughout the entire 256-character four. Pressing the Del key has the same
tto chop down the window size to, for example, an 8-jazie height, where and can
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The EGA and VGA Display: Rows vs. Character Height

Scan Lines	EGA Char. Lines	VGA Cher. Lines
1	350	400
2	175	200
3	116	133
4	87	100
5	70	80
6	58	66
7	50	57
8	43	50
9	38	44
10	3	40
11	31	36
12	2	33
13	26	30
14	25	28
15	_	26
16	_	25

Figure 2: The EGA display has 350 total scan lines and the VGA has 400. The number of displayable rows is calculated by taking the integer of the total scan lines divided by the character son lines. character (36 rows) or 12 scan lines (33 rows) seems more appropriate for the VGA, giving you more data as well as readability.) The number of lines available is shown listed on the FONTEDIT menu, and the table in Figure 2 correlates the number of displayable rows with the number of character scan lines.

You can delete any rows you want, but you may wish to start with the top and bottom blank rows that are used as part of the screen. Just remember that you can't delete an entire row from only a single character in FONTEDIT, so use FI (or Del) with caution. As with all large-scale data deletions, FONTEDIT warms you about what you're doing and deletes only after confirmation.

F2 inserts a blank row at the cursor position, again throughout the entire costion, again throughout the entire children. The same effect is achieved if you press the line key. Since the effect of pressing F2 (or linerit) by mistake can be reversed easily by pressing F1 before moving the cursor, insertion does not wait for confirmation. F2, Duplicate Row, works the same as F2 except that a copy of the cursor row is used for the insertion. The corresponding cursor row for each character is used for the duplication in that character.

The delete and duplicate functions can be used in concert to approximate the Playbill or Old West font. First, delete the top and bottom blank rows of the character box to give yourself some working room. Then thicken the serifs of all the capital letters by placing the cursor on both the top and bottom of a canital letter (F will do) and press the F3. Dup row. The newly formed font will quickly remind you of an old western saloon sign. Of course, some of the letters (all of the lower case) will need additional modifications to make the character set complete, but most of the work will already be done to this interesting new font with just a couple of keystrokes.

The F5 key. Copy Template, replaces the character in the Edit window with the Template window character. If you're editing a character and want to scrap what you've done and start over, pressing F5 will let you make a fresh start. Unlike the delete (F1), insert (F2), and copy row (F3) functions, which affect the entire character.

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BUTTOW_ENG:	CILL	UPDATE CURSON LOAD_CHAR	Update the cursor. Load the character.	LOAD_IV:	CALL CALL	SP, OFFEET EDGT FORT CHEE LOAD INTOBOATION	Load the new foot. Got foot information: Bote that foot o been modified Clear the old display.
					CALL	MODIFY FLAG, 1 CLE 16,06	prices the old display.
DO DOTES:	10 CMLL	ser cusson serts mo	(Is earson in character bon) (If no, ignore,	061.875_8901	EALL CALL	SET CUMOR DISPLAY COPY	shiepley new foot.
BITEL DID:	CALL	OPT CHAN BOT CHAN, AL. BEN CHAN	if no, ignore, price of the highlighted char, price at an new edit char, price by the edit character.	DELETE_RETURN	ART		,,,
				DRIGHE	-	01,81	postination starts at source.
LEPT:	BOV JNP	30,4770 Short Associa	(Movement = 9 rows; -1 cole.	BOST DELETE:	BOV POGR	01,81 CX,254 CX	1256 characters to do.
#00#Tv	200 200	BF,1 BROTT ARROWS	Movement + 0 rows: +1 cols.	CK_SKEP1	HOVE BONES	CH, MX CH, MP MRIP_MOV	BE hee bytes/cherecter. Is this the row to deleta? If yes, ellp it. Islae, move it down.
er.	NOV TOTAL	ar, territor	(Morement1 rows; 6 cols.	SRIP_NOV: LOOP DELETE:	JHP INC	SECON DOOR SELECTE	skip deletine row.
DOME:	399	DECET ASSOCIA	Aurement - +1 rever # cole.	LOOP DELETE	INC LOOP POP LOOP	CE SELF CE SELF	;50 all character rows.
NAME OF TAXABLE PARTY.	CML		Mesters current sersor position.		PRT		INC BIL 204 CHARGOTTES.
	MOV Jes	METPORE GET CUMBON CO, 37 CHAR ARROW		,			
	ADD CALL BUB BOY	CK BOUNDS	:II no, do character movement, :slee, double up col. movement, :move cursor; check the boundary, ;AX has position; make relative.	1910 NOW!	108 200	SECRY IND ROLF	;Insert + sero byte.
	MOV CALL CAP	SOLT CUSION, AN SS, LEST PINEL COT PINEL SSIPE STATE, S UPDATE PISSLE	:If no, do character movement, :Blee, double up cel, movement, :Bore curpor; check the boundary, Az bas position make relative, ;Bater as now edit cursor. ;Bater as now edit cursor. ;Bater as now edit cursor. ;Bater as move the law, ;Bater now flift bay degreement; If no, ophidat new cursor pos.	DEP_ROW:	CALL Jine HOV		
	08 386 308 AND	BO, GO BIT ON	:tlee, was lest pixel on? :If yes, dreg to new position. ;zlee, invert mask; ; and dreg pixel off.		INC NOV CHP JE STD	SF, POINTS SF, MAX LINES IMSENCENO	Adjust. potriove bytes/char. Cheracter maxed out? If yes, dose here. Else, beckered soven.
	300	STORY UPDATE PIRELL			ecv.	*1,CFFSRT EDIT_FORT	
\$57_OB:	œ	BETE PTR [DI], AR	yturn the pisel on.		CALL	INSERT TEMPLATE FORT	
UPDATE_PERELL: UPDATE_PEREL2:		MPDATE_CHROCK	;Lead the character. ;Update the cursor display.		NOV NOV 160	55, 30 55, 30	istring operation back Torward. Increment bytes/character.
					CALL CALL	SP, OFFSET EDST_FORT USER LOAD DEFCOMATION	Load the new font.
CHAR_ARROWS	CALL SUB HOV CHP JS CALL	CE BOUNDS AN, CRAR TOP CRAE CURSON, AN SELFY TRATE, B CRAE BED CET CRAE, AL EDIT CRAE, AL	Howe curser: check the boundary, 	IMENT_END	CALL BOV CALL PET	DEFORMATION MODIFY FLAG, 1 METTO_DEG	plet foot information, prote that foot's been modified shieplay new foot.
MEN_CHARL	CALL	DISPLAT_POST	pactor new casescer ton pos. pacton or thirt key depressed? :If no, done here. :Else, get the Churcher ; end sen as new odit Cherocter. ;bisplay it.	INCEST:	BOV BOV BUS	AR, MP CR, 254	pDo to end of fort (256 * points) - 1
CHAN_EPO :	RET	EPEATE_CURSON	jupdate the occupy display.		BETO BETO BOY	CK AN 61, AN DO, 61	
energy	ner		there leave adult character.			01, CX	:New foat * old foat * 256.
	2907	EDIT CHAR EMONT PACE END		HERT INDERT	POSIS NOV NOVES	CX, BP	Have cheracter count, Hetrieve bytee/cher. Hove s byte. It there en insert row?
PODMI	1300	EDIT_CHAR	:Next higher edit character.	- Siler		CL. BO LOCP_IMSERT	
PAGE_END+	RET	SETUP_END	torage of 15.		7910 900 08 28	AL, EL BL, BL DBBERT IT	off yes, secume sere insert.
TABL	CALL NOR CALL	RESTORE EDIT PLAG, 1 UPDATE_CURSOR	:sestere current cursor position. :Toggle Edit/cher active bos. :Display cursor in new box.	INCOT_INCOT.	STOCA LOOP POP	AL, [SIT1] MONE_BYTE	jie pare to be inserted; jif yee, quessed right. jales, deplicate with byte hele jreeset it. jbe ell bytes/char.

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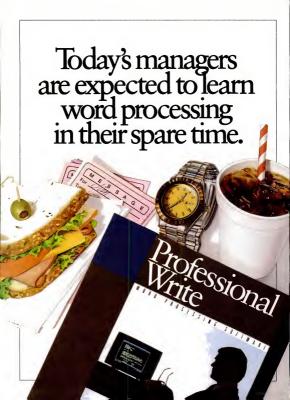
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	LOOP BET	NEXT_THORNY	;bo ell 154 cherectors.	CK_DOWN1	29 20	AN, MC BOOWDS END DB, BOIT NOW	If too far down, persp to top.
				BOUNDS_END:	HOV FOR	AR,PX	/Meturn copy of cursor position
OPT_TEMP:	HOV ADO	GRT PINEL 01,01 81,86X POCWTS - 256	Destination = Source+(16 * 156).		RET	-	promoted BX.
	HOV REP CALL	CB. POINTS MOVES SETUP END LOAD CHAR	(Myles/therecter to copy,)Copy them,)Update the display,)Lead the new character.	Dept			
	CALL	LOAD CHAR	Update the display. Lead the new character.			eor position.	
	RET			M = char	ecter.		
BAYE	CHP	PILE PLAC, 1	to there o filenson?	CET_CHAN	1909	CL, 4	Checacter = row + 16 + column.
	CALL CALL	SAVE_IT CLA GET MAKE	ilf yee, eave it. illes, clear erross. iGet e filename.		ADD ADD	AM, CL AL, AM	
	PUBLEF	DISPLAY NEAD	Bere results.				
	DOPP CALL	SAVE_BED SAVE_PILE	See Friends. Secieptey con. Secieptey con. If there exists. If there aborted, okip cave. See the file.	Post inform	etice. ;		
BANE IT:	RET	-		IBPORMATION	1904	89,3 57,11389	;Get infermation.
	180 OF C	CHECKED PROCESSING POUTLY	MES ************************************		NOV INT PURE	AE,11360 185 CS	:Restore extra segment.
OUTPUT					POP	ES POSSTS,CX SOMS.TC.	sitore hytes/cherecter.
OUTPUT If Ballt co If Char co OX - corec AX - relet	reer, s	im.			MIT	****	patent rom to action.
AX - relet	TAR BOR	ition, j		Piletane le	pareed	of white space and COM ex	tension technico.;
DET_CURBOR:	907 907	AN, BOIT_CURROR DB, AX	pheeme edit cursor; retrieve it.; cursor positité = relative; position = tep left of edit bus pare we in edit bus; lif yee, guesend right; pleen, retrieve ther, cursor; federulate cursor position.	*****	way	47.413	(Point to narameter.
	ADD CHP	DB, BOIT TOP EDIT PLAC, I CUMMON END AX, CHAZ CUMMON	position * top left of edit bus	MIT TAKE	Toosa	AL ARROY	sta it leading enace?
	25 907 907	AX, CHAZ CURROR	ilf yee, guseemd right. Blem, retrieve cher. cureor.		n oe	MEET PARED AL, TER CHAR MEET PERSE	ilf yee, iquore.
	A00	DE, AN DE, CHAR_TOP	pearente careir posteron.		90C 90V	FILAMON, SI	ilf yes, ignore. :Mdjust pointer. :Starm etect of fileneem.
CLARGON_END-1	PET			P280_8901	1000		
Return highl	ighted	corese position to back	ground. ;		CHEP 2000	AL, SPACE PARSE END	
RESTORE	MOV	BL, ATTRIBUTE	Background attribute.		CHP JB CHP	PARIE EFD AL. "A" CE DOT AL. "C"	(Capacitation)
	THE CALL	CHAN ARRIVAGE DRY FERRL	IT cursor in cherecter box? IT yas, restors that box. Blue, get pixel and write.		AND	CK DOT BYTE PTD [BI-1],598	
	CALL	WRITE PIERL	(Blee, get pixel and write.	78,0071 78840,0001	ZHE	CE DOT STTE PTB (SI-1), SPS AL,"," FIRD BWD DI, ST	ITS it a dot? Iff so, continue, Bloo, if dot or and of filenes tack so ".com".
CHAR RESTORE:	****	CRY CRAX MRTHE CRAX	gost character and write.	73348_001	ZA AND CHP JHS HOV BBC HOV HOV REP	DI SI,OFFSET COM	1 tack on ".com".
_	RET	WATEL CHAR			MOV	CX,5	
Bighlight me	v cereo	r poeition. ;		,	PAT		
UPDATE CURRORS		SL, ATTRIBUTE	Netrieve background ettribute.	if file a	elete,	g : 1	
CHANCE COMMON	CRIT.	BL, INTENDITY GET CURROR DO CHAN	Trues on intensity hit. To ourser in cherecter bos7 If yee, 60 character cureer.	1	*******	***************************************	
	JNE CALL			OPEN_PILE:	MOV	DX, PILEMANN AX, 30428 219	jopen file for reading, writing
PORT_CURSOR:	CALL	GET PINEL WRITE_PINEL	yBlee, get pieel and write it.	SAVE_HAMPLE	1307 1007	PILE MAPPLE, AN	phere filahendle.
DO_CHAR	CALL	GET CHAR DI, GOTSET BLANKS	;Batejavo character,		MET		
	200 200 200	CE,3 SCASS	Observation Observation	OUTPUT			
	JEE	DO CUMBON		If eucose	er er	- 1 ;	
po cussos:	CALL	WESTE CHAR	(Update the character curser.	CHEATE_FILE:	1077	EG, FILERANE	
	RET				908 909	CX,CX AN, 309 219	Creete normal file.
EMPET					CALL CALL	CREATE BHD SAVE_SAMEER SAVE_FILE	plf successful, nove filehandle
CE - Direc	Lice.	ear position.		CREATE_END:	RET	SAVE_FILE	; end eave font fale.
OUTPUT DX - Few C	ureor p	omition.		Read the pa	reed fil	e. Check if legitimate i	oet file. Loed the foot.
HE preserv	ed,	i		READ FILE:	1909	AX, FILE_HANGE	(Retrieve filehendle.
CK_BOWERS	ADD	08, 08	;Add row direction		907 907	AS, FILE MANDLE DE, OFFIST LOADER CY, LOADER LENGTH AY, 176	Retrieve filebendle. Point to loader. Potes to read. Pead from disk.
	ADD PUSE MOV CHP	DE, CE DL, CL AZ EL, 14	; Add row direction; ; end column direction; ; howe AX. ; Yee 16 se bounds for char. ; box helles.		MOV DATE	AX, 3FB 218 SI,OFFSST PROSBARGERI DI.OFFSST PROSBARGERI	pues mans se legitimate fent ; file signature.
	JES JES	EST PLAG, 1 CE LEPT SACPOINTE	your is so bounds for char- ; box bettem. ; box bytes/char bounds for edit ; box bottom.		NOV NOV NOV		; file eignature.
EX MET:			; how boilton. ;Add onlumn to relative pos.		CALL	CEPSW SEAD END DIMP_PILENAME DB_GFFSET MOT_FORT_MOD	
	A20 35E A20	AL,CL CS SIGNT DL,14 BROST BOOKDS END	IIf ton for left,		HOV JHF	DE, OFFEET NOT FORT HOS ERROR NOG	; If not feet file, esst ; with esseage.
CK SIGNY:	307			NEAD_830+	MOV	FILE FLAG, 1	
a_a,uef	31 533	AL, 16 CK UP DG, 16	; If too fer cight,		PORT MOV	BP, OFFERT BOLT FORT BB, BUTE PTR POINTS	Point to feet.
DE_OF		AM CR	padd row to reletive position.		CALL	CHEN LOND	paies, outs that filename rous fews filebendic. Point to feet. Bytos/Character, Load the feet. test feet Information. Patrices filebandle.
-	208 ADD	CK DOWS	iff ton far up,		POP	11	; Potriero filabandie.
	own	\$8087 B00900_220) wrap to notice	1			(FONTEDIT ASM continu

			1	100	INC	BL.	
LONE_PILE:	HUV INT BET	A9, 249 218		18PUT			
IAVE_PILE:	CALL	OPEN FILE DE, OFFSET LOADES CH, LOADES LENGTH	idean the file and write ; fort image end loader to disk.	AX - Mdit	charact of cha	er.	
	907 197 927 927 367	AG, 408 715 MODIFT FLAG, 0 FILE FLAG, 1 ENGIT CLOSE FILE	:Reset modify fiet. :Ente that have a filesame.	CRAN_START:	HOV HOV HOR PURH		(Metrieve bytea/character, (Metrieve sdit character, (Mern in high helf, (Frenerve character, (They attr) betweenter a char
SI - fire	string	to write.			HUL AZO POP RET	SI, AN	Preserve character. Preserve character. pchar start = bytes/char + char photo to ledex. Retrieve character.
If Treat				AR - ARCEL AL - SCAR	chars: code. button	ter. presed. It or hotton depresed.	
MERT 1	CALL MOV CALL CALL	TTI STRING DISF PILESAME EI.OFFRET YES NO	Mrite profess string. Mrite filename. Mrite quary atting.	,			
	CALL CRP AET	EL'OLNE OLL NET TET SERVE OLL NET TET SERVE TET SERVE TE	ruet a response. (check if "Y" pressed.	GRT_11099T1	HOW HOW HOW CHP JWS	BP, BP SEIFT STATE, S SUTTOME, S SOVER FLAG, I CK_EKTROAKD	Storm import in EP; start with EBern im Ebift state. SEre in Evitone also. Jim the moose active? JIT no, skip moose poll.
If same v.	ild, for abo	et - 6 ;			NOW TWI	BX, BX AX, 5 338	:teft betten. :Putton press infrimation.
ET_HARE	MOV	DE,OFFEST FILENAME, NED PRINT STRING DI, SLE			08 907 907	EFT SPITON, SC.	iBtore button degreesed info. Btore button press info. Do **mmm for Fight Dutton.
EXT_HAVE	CALL CAP STC	AX, HPC BCAX	: Use FEP's OTA for input, Get a heyatroke. Esc?		TAT OR CHP	SIGHT SUTTON, BL. SUTTONS, S INDUT_EAS	iBture button present Lafo. (Any button present) (If yes, doon here.
	71 71	NAME END AT, LEFT_ARROW SO AS AT, SE SCAN ACCESTED, SCAN	IIf yes, abort with CY = 1. Beckepare with left arrow or beckepare key.	HOUSE_HOVE OR 1	HIT AND ADD	AZ, 600	; Smad moose motion.
	71 CHP 71	DO BE AN, METER SCAN STORE STRE	IIf Mater key, done here.		MON	CS, NONISCHTAL DR. WESTICAL AN, NICAME	; Add to lost burggestal motion; and least vertical motion; ;Rattleve mouse unit of wollow.
10 BS :	288 289 080	STORE SETT AL, SPÄCE SERT SAME SBORT STORE_STEE DI	Ignore space and below. TTT Serkspace = the characters 0, space and 0.		HOV CHP JS HOV CHP	BI, BIGHT ARROW CS. AX BORIS BI, DM ARROW DK, AX	Assume right movement. Is becimental > mickey> If yes, quesed right. Assume down neveront. Is vertical > mickey> If yes, quessed right.
	POP POP CALL BOY CALL POP JND	AZ MAZ MALTE TIT MALTELITY AX	; 4, space and 4.		HES HOY CHP	VEST	iif yea, queaned right, 181as, mente mickey, channe ist meserent, 12s horismotal 4 nickey; 12f yea, queened right, pasene go movement, 12s westigni 6 mickey; 12f yea, queened right.
1700E_BYTE:	STORE CHP	AN DETER SCAN	stone if fater.		OKP OKE	EI, LETT AUGUS CE, AX BORIZ EI, UT AUGUS DE, AX BYORE, HOVIOR	Masons up movement. Is weetheal < morkey! If yes, quested tight.
COPLAL_STTE	CALL CALL	PARSE IT WRITE TIT SHORT HEST DANK	:Echo imput to ocrees.	VERT 1	310 310	DE, AN STORE SCAN	Bubtract wertical mickey. Opdate wartical.
171_0084	CALL	PANES FILE SOUN FILE CARATE IT \$1,077EST BRIST_MAG	param the filenome. pase if it smight. If me, erests it. Phine, such if aboutd write over existing file.	STORE SCAP: STORE SCAP:	NOV.	CE, AX EP, EI	:Subtract horsectal suckey. State acao code to Sr. Updata movementa.
	MOV CALL	BI, OFFERT BRIST MAG PROMPT CET MANE	: Blee, ask if about write ; over existing file.	CE RETROMO.	MOV MOV	MONITOWING, CI VENTICAL, OX	impeats movements.
TREATS_ITS	CALL 2007 CALL		present the fair.	ti_iiiiiiiii	THT AND	AF, 2 140 AL, MIFT MEIS MIFT STÄTS, AL	mask off all but Shift keys.
ME DES	CALL Jup BAT	CHEATE FILE HAME END DX.OFFSET PAILED HOD PRIST STRING ENDRY CET BAME	III failed, inform user I and mak for new fileness.		NOV INT	AW_1	;Repetroke statue.
					CMT CMT CMT	STORE INPUT OUT MET AL, EX SHORT INPUT EXD	:If none available, done here: :Blse, get beyetroke :Exchange scss/ASCII code.
AL - PINE SI - POIA DI - POIA PINEL - 6	L OR or ter to a	PIREL OFF Annt of Character : tart of Scan Line :		STORE_EMPTY	HOV OR JUS CHIP	-	Setury legal is AX In there legal? II yea, does here. In there betten pressed? II yea, does here. Files, walt catal imput.
NT_PINEL	MOV.		Point to start of edit finat.	18997_8801	CHP ZHK ZHP RET	AE, AN EPROT END EUTTORS, A ENDOT END ERT_IRPOT	;Is there botton proceed? ;If yes, done here. ;Else, wait cattl imput.
	H07 H07 111	CL, I	Proint to start of edit finat. [Index to currant character, plane into DI. [Natriawe edit curant, Prov col/bit se divide by two. [Sit starts is most significant. shift bit to chimm position.	DISPLAT_FORT:	NOV 180	AL, NOWS	Hetrieve rows on ect-on.
	HOV HOV HOV HOV HOV HOV HOV HOV HOV HOV	AF,CL CL,CH CF,CH CF,CH	Shift bit to enjume position. Now is CL. Now is bigh kaif. Add to observer start. Satyiave the coverat byts. Sature it is off.		HOV HOV CALL	AL DE, 34EM CR. 3 ML, ATTREBUTE DIVINE	Display at New 2; Col. 77- Three bytes to write. Use background attribute. Display the number.
	HOV HOV AND	CL. (02) AL. FIREL OFF LAST FIEL, 6 CL. AR			HOV HOV CALL	DE, SOE TOP + 1838 AL, SOIT CHAR WRITE CHAR	Print to iraids of info box. patrieve character. plupley it.
DED PIERL	JS HOV HOV RET	NO PINEL AL, PINEL OF LAST PINEL, -1	page with bit manh. off off, quased right. office, pinet is me.		AZO NOV CALL	DE.7 CH,3 DIVIDE	:More to sed of member col. :Three bytes to write. :Display the number.
OUTE_FIRST.	CALL	MITT CHA	;Two characters/pissi.		HOV HOV CALL	SP. TEMPLATE TOP 61, OFFSST TEMPLATE FOST UPDATE FOST	ibleptey template character.
	THE	NA LTE CHAR	, no canacaropina	1	CALL	CPOATS_FORT	(FONTEDIT ASM continua

■ UTILITIES

March Marc		16/N	BF, FOIT TOP BI, OFFSET EDIT_FORT	:Display whit character.		CPT	SET_MEGZITTIS	
Proceedings	POATE_FORT:	CALL	CHAR_START	(Metriare lains to class tot.		CALL		Point to character to upload.
## 15 15 15 15 15 15 15 15	ENT_LINE:			;Get a byte.		906	CL,5	
## 1967 -		1007	22.A5			BOY.	DI,AR	limme at abbacharage causes
## 1985 1985				preserve bytes/riss.		POP BOY		:Poist to feet segment.
Company Comp						NOT NEP	ES,AX MODES	:Uplead the bytes.
March Marc	HRT_PIXEL:		01,1	det a bit.		POSS		:Nestore estre popment.
March Marc		20	DESPLAY TY	:Did but end up in certy flag?		NOV	EI, OFFEET PROTECT AFECE	
Married Marr								
March Marc	CEPLAT_ITI	LOOP	WRITE FIREL	De all # pia-ls.		MOV NET	MODIFT_FLAG,1	smote that foot malifact.
The content of the		ADD	BP,1558	steet display row.	,			
The content of the		LOOF	ENT LINE	(Se #11 rows.	BET CINDOD:	2011	AX	
Married Marr		PET	-				20, 20 20, 2	(Bet ourser resilier.
Section Sect	IMPER					187	188	
March Marc	Ketry point	- 01V	106. 1			RET	-	
March Marc	BL - Attri	bots.			1			
March Marc	DE - Ceres	r posit	166. 1		NIDE CLESON:	BOT	DE, BOVE	
March Marc							95.95	:Nide curser one row below
The content of the			AX, SPACE			CALL	MET_CUMBON	displayable rows.
Compared		28	ARCH	off yes, display space instead.				
## A PART		X0R	AX, AK	Seco to high helf.				
Company Comp			AR, *9*	Convert to ACCII.	CLEAN MENTS	BOT	13.3678	Dow 3: column 75.
March Marc	actte	CALL	MALAN WRITE CHAR	Remainder to AL. Outpley it.				
Married Marr		DOM:	AZ.AN	(Back to AR. (Been back one relum.	CLS1		CX, CX DX, BOND	(Now mercy column erro.
The content of the		LOGP	WENT COUNT	:Display all three bytes.	action .		00,79	
March Marc		~~.				MOV		(Scroll window of setting pap
March Marc	INPUT	•••••	• ;					
March Marc	ML - Chere	cter	1			CALL	SET CURROR	
March Marc	Ax, ex pre-	served.	i			XET	-	
March Company Compan					1			
The part of the								
The part of the		PUED	CX		GET ART	204	AT,AX	
The content of the		CALL	ca.T		GET_ART	200 297 387	169	
The content of the		MOV	ca.T	sterite ettribute/dimension.	GRT_ARY	INT NAT	AE,AE 169	
March Marc		HOW HOW INT POP	CX.T AX.9	iBrite ottribile/Ulbracier.	,	NAT	168	
March Marc		HOW HOW INT POP	CX.T AX.9	SErite stirikale/klasakles.	,	MAT MOV JET	168	
Company		HOW HOW INT POP POP ANT	RET CERROR CE.T A4.9 10b CE A5		,	MAT MOV JET	168	
## 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		HOW HOW INT POP POP ANT	RET CERROR CE.T A4.9 10b CE A5		PRIOT, 8793.001	MAT MAT ART	148 218 218	
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set, F5 Copy Temp(late) writes over the current character only.

You can save the font file at any time simply by pressing F4. If you did not give FONTEDIT a filename argument on the command line, you will be prompted for one when you hit F4, and once FONT-EDIT has a name for the file, that name will appear right after the F4 Save in the menu. As with all data processing programs, you are encouraged to save and save often. If you forget to save and attempt to exit FONTEDIT with Esc, FONTEDIT will give you the opportunity to save the font file before returning you to DOS. FONTEDIT keeps track of any modifications you have made to the font and bothers you with this warning only if the font has been edited since the last update. Along with the font descriptors, the current edit character and cursor position are saved so that the next time you start FONTEDIT with the same font file, you

can pick up exactly where you left off.

The font files are one of the handiest aspects of FONTEDIT. When you save a file you not only save all the font descriptors but also automatically add a very short but

■ The font files are one of the handiest aspects of FONTEDIT. Saving a file

adds a header in .COM format that loads the font.

sufficient header code in .COM file format that will load the font. All you have to do is enter the name of the file at the command line, and the font will be loaded into video

RAM. You can just as easily load a font

from a batch file.

Since the loader is in .COM format, the file must have a .COM extension to work properly. The easiest way to accomplish this is to let FONTEDIT add the file extension for you. When you give FONTEDIT a filename to store the font, you can either give it a .COM extension yourself or let FONTEDIT tack on the .COM for you. If

FONTEDIT tack on the .COM for you. If you give the file any extension except .COM, FONTEDIT will ignore it and add the necessary .COM. Don't worry about writing over any existing files. You'll be warned before FONTEDIT does this.

Pressing Esc at any time exits FONT-EDIT. When you return to the DOS prompt or check the screen after loading a FONTEDIT-created font, you may find that the cursor has turned from an underline to a minus sign or has disappeared altogether, especially if you have loaded a font shorter than the 14 or 16-line-hiele

UTILITIES

default. The incorrect cursor restore is the result of a log in the Eds. BIOS, and correcting it would call for so much special case code that FORTH the factors. The factors of the FORTH the factors of the factors of

ADDITIONAL LIMITATIONS FONT-EDIT imposes a naximum of 14 sea in EDIT imposes a naximum of 14 sea in EDIT imposes a naximum of 14 sea in the native of 14 sea in 14 se

Also note that if you have and intend to use the mouse with FONTEDIT, be sure the mouse driver is installed. If you use the mouse often, you probably already have an entry

DEVICE = MOUSE.SYS

in your CONFIG.SYS file. The other, more flexible option is to load MOUSE .COM at runtime before loading FONT-EDIT.

There is one major potential problem for which FONTEDIT itself can offer no solution. A number of applications, when loading, may replace your carefully sculptured font with the default ROM font. The reason for this is that each time a video mode is changed, the BIOS loads its font. Applications sometimes change the video mode (even if it's to the same mode) because, along with loading a font, the BIOS also clears the screen. Changing modes is, therefore, an easy way to start with a clean slate. You can use these mode-change side effects to your advantage if you wish to return to the default font after customizing or loading one of your own by entering the DOS command:

if you have a color system, or HODE HONO

if you have a monochrome system.

If your favorite application refuses to use your taste in fonts, there is one possible solution—if the stubborn application lets

■ The incorrect cursor restore results from a bug in the EGA BIOS; fixing it would call for so much special case code that FONTEDIT doesn't bother to handle it

you execute DOS commands. Once your application has loaded and mude its next, samply abell to DOS and load your fost. This too map fail, however, if the application insists on resetting the video mode again on return. And even if your application is polite and accepts PONTEDIT's fosts, you may still not be able to get the full benefit from shorter forts that enable more character lines. Many applications always assume there are only 25 lines to the disphy regardless of what's available.

HOW FONTEDIT WORKS Programming FONTEDIT presented a challenge right from the start. Obviously, if you don't indicate otherwise by including a filename argument, the program should grab and display the current font. The problem is that there are no BIOS calls that tell you what the current font is. Information BIOS service (interrupt 10h, function 11h, subfunction 30h) returns the pointers to the available ROM fonts, but it doesn't tell you which one of them is loaded. Even if it did, the loaded ROM font may have been modified since BIOS loaded it, especially if you're using FONTEDIT. Thus, FONTEDIT had to go directly to the source where the current font descriptors are stored-segment A000h-and this in-

volved some problems of its own.

The MDA (monochrome display adapter) and CGA (color/graphics display adapter) video buffers are stored in segments B000h and B800h, respectively. The same video buffers are used for EGA and VGA text modes. The reserved segment A000h, above the 640K RAM barrier, is used for two different purposes. It is used both for the newer video buffer higher-resolution graphics modes and to store the font descriptors when in a text mode. When you change to a text mode, the BIOS loads the appropriate font into this segment from ROM. Then, when the video hardware reads a byte of text from the video buffer segment (B000h or B800h), it looks up the character description to send off to the display in A000h.

This sharing between the video hardware found descriptors look up table to mode and the actual pixel image when in graphics mode makes access to the A000th segment a little more difficult. In fact, when in text mode the found descriptors can be accessed only by the video hardware. You can quickly convince yourself that you cannot normally access the font segment by loading DEBUG and entering the dump command.

D A888:8

Instead of a display of the font descriptors, all you'll see is a bunch of FFs. Obviously, there has to be a way a program can gain access to A000h, since the BIOS loads character fonts to it. And there is, but it takes special programming of the video adapter registers.

For each video mode, the BIOS has a separate parameter look-up table for setting the numerous video registers. In order to access A000h, the BIOS uses the reserved video modes 0Bh (for a color system) and 0Ch (for a monochrome system) as an index to the special register parameters. All of the video adapter registers are set, though only the Sequencer and Graphics registers need to be programmed to access the font segment. (As happens so often in programming, it's easier for the BIOS to have one all-purpose procedure-in this case, program the entire register set-than it is to have several specialized procedures.) FONTEDIT wants to be able to get the current font descriptors, so it

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FONTEDIT.COM is already compiled and ready to run. FONT-EDIT.BAS will automatically create FONTEDIT.COM when run once in RASIC FONTEDIT. ASM allows you to modify the program but requires you to use a macro assembler (IBM or Microsoft, Version 2 or later) and the following commands:

MASH FONTEOIT; LINK FONTEOIT:

EXE2BIN FONTEOIT FONTEDIT.COM

Photocopy this page. Trim and holepunch the copy and add it to your DOS manual.



FONTEDIT Command

Commands

Michael I. Mefford Purpose:

1988 No.15 (Utilities) Permits modifying/creating EGA or VGA character fonts

Format:

Remarks:

with keyboard or mouse and saving the new fonts as .COM files that can be loaded from the DOS prompt. [d:][path]FONTEDIT [filespec]

If no font filename and path are supplied as the filespec, FONTEDIT uses the currently displayed font, beginning with the letter A. Pixels in the Edit window are toggled or or off with the spacebar or with left and right mouse buttons. The highlighted cursor may be moved within the Edit window by mouse or with the cursor Arrow keys, and it can be "dragged" to adjacent pixels by holding down a Shift key or mouse button. Editing changes are saved by pressing F4, and opportunity is provided to supply a missing filename. FONTEDIT will supply the requisite .COM extension automatically. Esc quits the program.

Pressing F5 copies the original character template to the Edit window. New characters to edit can be loaded by pressing the appropriate key on the keyboard, by pressing the PgUp and PgDn keys (which move in ASCII sequence), or by holding down the Alt key while typing the ASCII code on the numeric keypad, then releasing Alt. The Tab key toggles the cursor between the Edit window and the full Character Set window. Highlighted characters in the latter can be loaded for editing by pressing Enter or one of the mouse huttons

The F1, F2, and F3 keys affect all characters within the entire font. F1 (or the Del key) deletes a whole row of pixels and is used to shorten the height of the character box. The default (and maximum) character box size is 8 pixels wide (this cannot be changed) by 14 pixels high (EGA) or 16 pixels high (VGA). A 43-line EGA font uses a character box of 8 by 8 pixels, for example. When F1 (or Del) is used, confirmation of the deletion is required. F2 inserts a blank row of pixels throughout the entire font (maximum height permitting), and F3 copies each character's current pixel map, as, for example, to thicken a

Modified or created fonts are loaded simply by entering their names at the DOS prompt. Normal operation is restored by entering any video-mode command—for example, MODE COBO—on a color system or MODE MONO in monochrome. Applications that reset the video mode on entry or when returning from DOS also restore the default ROM font and cannot be used successfully with FONT-

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too has to program these two sets of video registers The converse, loading a font into the

A000h segment, is a lot easier. Here there is a BIOS call (interrupt 10h, function 11h, subfunction 0, User Alpha Load) that will

load a font for you. For that matter, it could be used to load a new description of just one character, though for reasons that will become clear, FONTEDIT does not use it for single characters. All you have to do is set a pointer and indicate how many bytes

per character, the starting character, and how many characters to load. The User Alpha Load service is especially useful when you delete or insert a character line in a whole font because, besides loading the font, it does all the calculations necessary

BIOS call (interrupt 10s, tunction 11st, or single sea point uncertainty). If or single sea point uncertainty is a sea point of the sea point 1100 11110 1110 110 OATE A
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to set the CRTC (cathode ray tube controller registers for the new scan lines. CRTC registers are responsible for things like the horzontal and vertical scan lines, cursor type, mode control, and maximum scan controls the number of scan lines per character row and is changed when you delete or insent a row with FONTEDIT. The same User Alpha Lood call it sued by the CRTC register of th

The bad news about User Alpha Load is that resetting the CRTC registers causes the display to complain by ballooning or rolling over for a moment. Although harmless and normal for the equipment, the sudden change in the screen size can be quite alarming to the user. (The VGA doesn't seem to be affected quite as much as the EGA.) I decided that the screen bounce was tolerable when the display resizes for line insertions and deletions and for the font loader program, but since FONTEDIT also reloads the character being edited every time you modify a single pixel, the User Alpha Load approach was unaccentable for editing. Every time you changed a pixel the screen went bonkers!

The FONTEDIT procedure that programs the adapters' registers to access segment A000h to retrieve a found does not program the CRTC registers. This same access procedure is, therefore, used to load single characters so that the display re-

mains steady.
If you dive into the details of FONT-EDIT's assembly code, you will discover that the video A00M font descriptors have a fixed 32-byte record for each of the characters. That means character could have as many as 32 scan lines per character abig font. Smaller, normal-sized format, the balance of the record just is not used. The start of the next character, therefore, is always two paragraphs away.

FONTEDIT must also store the font descriptors in its own memory. Two copies of the font are actually kept: one for the edit set, and the other for the template. Unlike segment A000h, FONTEDIT'S font descriptor record format is variable in length and depends on the number of scan

lines. Right after the end of one chaoseter, whether it be I line or FONTEDIT's maximum of 16 lines, the description of the next is started. (This is the same format required by the User Alpha Load BIOS and is the reason I chose to use it.) The starting offset for the template fort is a fixed 10 er 256 = 4,006 bytes from the start of the cold from, which necessite and of the cold from, which necessite and the properties of the cold from, which accommodates the start of the cold from, which are commodates the reason of the cold from, which will be short to disk, together with the short loader code, each of your fortifies will be

■ The video A000h font descriptors have a fixed 32-byte record for each character, which means a character could have 32 scan lines—a big font.

just over 8K. For smaller fonts, FONT-EDIT could have snuggled the template and edit fonts closer together, but the additional code was not worth the savings of the few extra bytes of disk space.

AN EXTRA PIXEL The EGA video memory is 640 pixels wide by 350 pixels tall. For the normal display width of 80 columns, therefore, the EGA character box is 640 / 80 = 8 pixels wide. In contrast, the VGA display is 720 by 400 pixels. Subtracting 640 from 720 leaves 80 pixels more on the horizontal axis; that is, one extra pixel for each character. This 9th pixel for a VGA character is not addressable, however. Rather, the hardware automatically inserts it as an extra blank space between characters. At least this is true for most of the character set. For the 20 special box-drawing characters, the 9th dot is displayed the same as the 8th so that the characters will connect on the horizontal. (The EGA connected to a monochrome monitor also has a 9-bit-wide character box.) Containing the 9-bit-wide VGA character box in 8 programmable bits conveniently maintains a 1-byte descriptor per scan line. FONTEDIT uses two solid block characters (ASCII code 219) to represent an "on" pixel and checkered characters (177) to represent an "off" pixel. (Two characters side by side is the closest approach to maintaining the proper aspect ratio of 1 pixel.) The difference between the EGA 8-bit-wide characters and the VGA 9-bit-wide can be demonstrated with these two high-ASCII graphic box characters. As I mentioned above, the EGA character box is 8 pixels wide and the VGA is 9 pixels wide, with the 9th bit an inserted offpixel as background for white space between characters. On an EGA, two of FONTEDIT's pattern characters (177) abut physically on the display. The result-the checkerboard pattern-is consistent throughout FONTEDIT's edit box. Since the VGA inserts an extra off bit. however, the same two characters side by side appear to have a vertical line between them. This doesn't happen with the solid block character (219), however, because that falls within the box-drawing character set (192 through 223) that repeats the 8th bit in the 9th normally-off white space. The result is that the two solid block characters touch each other in both the EGA and VGA, and two adjacent checkered characters on the EGA appear as one, but the VGA displays a blank vertical pixel

line between the characters.

The extra 9th bit might influence how you customize your fonts. The EGA 8-bit characters use only 7 of the bits, the 8th between the properties of the bits, the 10 the

HIDING THE CURSOR The familiar underline cursor you see at the DOS prompt would be a distraction on the FONTEDIT display. Previously, when a cursor was not desirable, I've hidden it by setting bit 5 of the cursor start fine to 1 (2000h), using interrupt 10, function 1 (Set Cursor Type). This causes the cursor not to be displayed at all.

The problem with this technique is twofold. First, ultimately restoring the cursor from the CURSOR_MODE BIOS data area is not reliable because the BIOS does not always update this variable correctly. Second, (and this problem is part of the whole cursor nightmare that I mentioned above), the cursor registers are not readable. A better solution for hiding the cursor would be to park it one row below the displayable rows on the screen. The number of displayable rows is returned in DL from the Information interrupt 10 call, function 11h, subfunction 30h.

PROGRAMMING FOR THE MOUSE The power of the de facto standard Microsoft mouse driver makes supporting a mouse an absolute pleasure. All requests for service are made through interrupt 33h with the specific function requested in the AX register. The mouse driver even takes care of placing the mouse cursor (a solid box in character mode and, by default, an arrow in graphics mode) on the display and moving it around. I'd have liked to have used the mouse cursor in FONTEDIT (just

to illustrate its ease of use), but, unfortunately, the mouse cursor did not meet FONTEDIT's needs.

As you may recall, FONTEDIT uses two adjacent characters to represent 1 pixel. Both of these characters must be

 Supporting a mouse is a pleasure because of the

Microsoft mouse driver.

de facto standard

highlighted at the current cursor location to orient the user properly, and the mouse driver uses a one-character cursor. Moreover, even if the cursor size were not an obstacle, FONTEDIT would have had to implement two sets of cursor logic, one for those who have a mouse and another for those who do not. Most programming circumstances, fortunately, do not force a programmer to encounter this dilemma. A single-character cursor will suffice, and if the mouse driver is not present. Alt-key combinations are used for command entry and the mouse cursor code is ignored.

(You may notice that FONTEDIT takes a lot longer to load if a mouse is detected. Other mouse-aware applications suffer the same delay. The reason for it is the Mouse Reset and Status call (AX = 0) necessary to initialize the mouse driver.)

For more on mouse programming, see Jeff Prosise's PC Lab Notes column "Mouse Software: See How They Run," in our July 21, 1987, issue. The Microsoft Mouse Programmers Reference Guide is recommended for complete details of all the parameters for the calls, for programming examples involving interfacing to

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higher languages, and for the RIL (the EGA Register Interface Library) calls. The RIL is necessary for any program that plans to manipulate the video adapter registers and use the mouse cursor, though, as noted above, FONTEDIT itself programs these registers and so does not use the suggested RIL interface. FONTEDIT can get away with this because the mouse cursor is never turned on.

CUSTOMIZING If you would prefer a blinking rather than a high-intensity editing cursor, you can use DEBUG to change a copy of FONTEDIT.COM by entering

DEBUG FONTEDIT.COM E 74D 80

0

Similarly, if you have a color monitor and you don't like FONTEDIT's color scheme, while you're in DEBUG you can

change the default blue by entering:

E 4CA XX E 4CF VV

where xx is the color (in hex) for the windows and yy is the color (also in hex) for

 FONTEDIT represents the best of both worlds-a practical application that's just plain fun to play with.

the copyright bar. The default colors are 17h for the windows and 71h for the copy-

For a more in-depth study of the EGA and fonts, see Charles Petzold's excellent

two-part "Exploring the EGA" Utilities column in our August and September 16, 1986, issues. Additional programming information can be obtained by ordering IBM's EGA supplement (part number 6280131) and/or its supplement on the PS/2 Display Adapter (VGA) (part number 68X2251). The phone number to call is (800) 426-7282

Generally, utilities are either useful or fun. FONTEDIT represents the best of both worlds-a practical application that's just plain fun to play with. If you don't like the placement of a character on the keyboard, you might use FONTEDIT to redefine its position. If the Dvorak keyboard layout sounds appealing, you could use FONTEDIT to redefine the entire keyboard. Whatever you decide to do, have fun with FONTEDIT

Michael J. Mefford is a contributing editor of PC Magazine.



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PRESENTATION MANAGER DIALOG BOXES, PART 1



Now that we've constructed Presentation Manager menus, it's time to upgrade our sample BOXES program to include dialog boxes, which add more flexibility to the user interface.

In the last two Environments columns, I showed a simple Presentation Manager program that draws a series of nested boxes in its client window. The first version of this program (called BOXES1) is simply used the default foreground and background colors to draw the boxes. In the second version (BOXES2), I added a menu to select the background and foreground colors. This is brequired reading a menu template in a resource script file named BOXES2 aRC.

I'll discuss the final version of this program (BOXES3) in this column and the next. BOXES3 allows you to change both the number of boxes the program draws and the increment used for spacing the boxes relative to each other.

A menu is not quite adequate for these enhancements to the program. A menu is fine when only a few options are involved, but this job requires a facility for letting the user enter a wide range of numbers. That's an ideal candidate for a 'dialog box.''

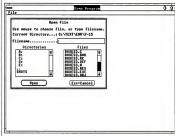
CONTROL WINDOWS Figure I shows a dialog box used in some Presentation Manager applications for opening a file. This dialog box is not part of the BOXES3 program.) A dialog box is often invoked from a menu item. The user fills in or selects options in the dialog box and finishes up by "pressing" one of the buttons at the bottom. The dialog box goes away and the user resumes working with the program.

A dialog box is a window or, more precisely, a collection of windows. The rectangular area occupied by the dialog box satisfies our intuitive notion of what a win-

dow is, but all the items inside the dialog box are themselves also windows. These are often called "control windows" and they include the text strings, the text entry fields (surrounded by a rectangle), the two list boxes (listing disk drives, directories, and files), and the two oval "push buttons" at the bottom.

A window displays output on its rectangular area on the display, and it receives input from the keyboard and mouse. As I discussed in the last two Environments columns, each window is associated with a

particular window procedure. The window procedure processes messages to the window (often resulting from keyboard and mouse input), and it draws its output on the window during the WM_PAINT message. The window procedures for the dialogs but the control of the various procedures and the control of the various control of the control issue's Environments column, a Presentation Manager application can share processing of messages with these window procedures.



■ ENVIRONMENTS

WINDOWS AND INPUT The Presentation Manager notifies a window of keyboard and mouse input by sending a message to the window. (This is equivalent to calling the window procedure and passing a message identifier and message parameters to the procedure.) For example, the message for keyboard input is WM_CHAR. The message parameters eontain the scan code. ASCII code, virtual key codes, and other important information. When you press a key on the keyboard, the Presentation Manager doesn't send a WM_CHAR message to every window in the system. The one window that gets the keyboard message is called the window with the "input focus."

When you first invoke the dialog box shown in Figure 1, the text entry field (window) has the input focus. A control window indicates it has the input focus by displaying a cursor of some sort. You ean type in the name of a file and press Enter. Or you can use the Tab key to move the input focus among the controls. If you shift the input focus to the first list box, you can use the cursor movement keys to select a new disk drive or directory. This is how the window procedure for the list box handles keyboard input. After you've selected a file, you can shift the input focus to the Open button and press the Spacebar.

The Presentation Manager handles mouse input differently. There are several different mouse messages, including WM_MOUSEMOVE, WM_BUTTON-IDOWN, WM_BUTTONIUP, and WM_BUTTONIDBLCLK ("double eliek"). The Presentation Manager sends mouse messages to the window underneath the mouse pointer. You can also use the mouse to move around the dialog box. to select files or directories from the list boxes, and to press the buttons.

When a Presentation Manager program uses a dialog box to get information from the user, the program itself usually does not have to handle the mouse and keyboard input. Instead, the input is handled by the various control windows. These windows then notify your program of user selections through other messages.

DIALOG BOXES IN BOXES3 Figure 2 shows the new drop-down menu that has

down menu has two items, "Number and | Increment" and "About Boxes3", followed by an ellipsis (" . . . "). By convention, the ellipsis indicates that the menu

on this new menu is "Exit" which terminates the program.

When you select the "About Boxes3" item from BOXES3's menu, the dialog item invokes a dialog box. A third option | box shown in Figure 3 is displayed. This

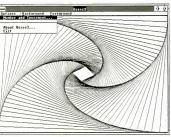
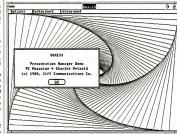


Figure 2: The Options item in BOXES3 displays a drop-down menu to invoke dialog boxes.



been added to BOXES3. This new drop-

type of dialog box is often called an "about box" and it typically provides some simple information about the program, such as a version number and a copyright notice. You get rid of this dialog box by clicking the "OK" button using the mouse, or by pressing the Spacebar, Enter, or Esc kev.

pressing the Spacebar, Enter, or Esc key. The second of BOXES3's dialogs is shown in Figure 4. This dialog box is shown in Figure 4. This dialog box is thought of the State of the State

THE RESOURCE SCRIPT You'll recall from last issue's column that the program's menu is defined in a resource script file. Dialog boxes are defined similarly. The BOXES3.RC resource script file is shown in Figure 5.

You'll notice that the new drop-down menu is defined in the menu template exactly as were the "Background" and "Foreground" drop-down menus. The identifiers IDM_NUMINC and IDM_ABOUT are defined in the BOXES3.H

header file, which is shown in Figure 6.
As was also discussed last time, the menu uses these identifiers in WM_COM-MAND messages that the menu window sends to your program's client window

when a user selects an option. The line MENUITEM SEPARATOR

adds a horizontal bar to the drop-down menu, as you can see in Figure 2.

The Exit item on this menu requires a little more explanation. You can usually exit a Presentation Manager program by selecting Close from the program's system menu. In that case, the system menu window sends the client window a WML_SYS-COMMAND message with a menu item identifier of SC_CLOSE. This initiates the termination of the program.

In addition, it is customary to add an Estit item to the first drop-down menu in a Presentation Manager program. The Exit item is given a menu item style of MSL.SYSCOMANO, this identifier is Figure 5: The BOXESS RC resource script file defines BOXESS's dialog boxes.

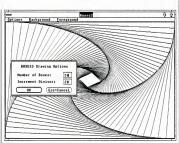


Figure 4: A user of BOXES3 can set new display values using this dialog box.



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DIALOG **, -1, 18, 188, 124, 86, 1	
DEFFUSEBUTTON "OK"	DID_OK, 64, 8, 32, 14, Ms_GROUP
CTEXT *Presentation Manager Dec CTEXT *PC Magerine * Charles P- CTEXT *(c) 1986, Eiff Communic	etsold* -1, 16, 42, 146, 10
CTEXT "BOXES 3"	-1, 10, 74, 140, 10
DIALOG **, -1, 10, 100, 160, 96,	RE_SAVEBITS FE_DLGBORDER
SLOTENPLATE IDO ABOUTBOE	
,	
MESUITER "Brown",	IDM FOREGROUND + 14 IDM FOREGROUND + 15
MENUITEM "Dark Green", MENUITEM "Dark Cyan",	IDM FOREGROUND + 12 IDM FOREGROUND + 13
MENUITER "Dark Pink",	IDK FOREGROUND + 11
MENUITEN "Dark Blue", MENUITEN "Dark Red".	IDM FOREGROUND + 9 IDM FOREGROUND + 18
MENUITEM "Dark Grey",	IDM FOREGROUND + 8, MIS EREAK
MESUITEM "White",	IDM FOREGROUND + 6 IDM FOREGROUND + 7

defined in one of the Presentation Manager header files.) When you indicate in the menu template that a menu item has this style, the menu window will send a WM_SYSCOMMAND message rather than the normal WM_COMMAND message. The menu item identifier for Exit is SC_CLOSE (it's also defined in a Presentation Manager header file). Thus, selecting Exit from this menu has the same effect as selecting Close from the system menu.

THE DIALOG BOX TEMPLATE The layout of control windows in a dialog box is described in a dialog box template in the

```
BOXES3.B header file
#define ID HAINMENU
                              1
#define IDM NUMINC
#define IDM ABOUT
#define IDM BACKGROUND
                           0x16
#define IDM FOREGROUND
                           8×28
#define IDD NUMINCBOX
#define IDD_ABOUTBOX
#define IDD NUMBOXES
                             18
                             11
```

Figure 8: The BOXES3 . H header file.

resource script. Templates for the two dialog boxes in BOXES3 are defined toward the end of the BOXES3.RC listing.

Each dialog box template begins with the keyword DLGTEMPLATE. The identifiers IDD_ABOUTBOX and IDD_ NUMINCROX are defined in BOX-ES3.H. These are used to identify the two dialog box templates. The definition of the dialog box is enclosed within a pair of curly braces.

In the definition of each dialog box, the words DIALOG, CTEXT, LTEXT, PUSHBUTTON, DEFPUSHBUTTON, and EDITTEXT are keywords that are recognized by the resource compiler (RC.EXE). Each of these keywords corresponds to a window in the dialog box. The DIALOG line contains a description of the main dialog box window. The other keywords are followed by descriptions of the control windows within the dialog box. The CTEXT and LTEXT controls are

text strings. CTEXT stands for "centered text" and LTEXT stands for "left text." The two push buttons at the bottom of the second dialog box are identified by the keywords DEFPUSHBUTTON ("default pushbutton") and PUSHBUTTON. The default pushbutton has a thicker outline, as you can see in Figure 4. Each keyword is



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followed by a text string that appears in the window, followed by an ID code for the control.

The identifiers DID_OK and DID_CANCEL are defined in a Presentation Manager header file, and the identifiers IDD_NUMBOXES and IDD_INCRE-MENT are defined in BOXES3.H. These are used by the control windows to identify themselves when they send messages. For example, when you click the "OK" button, the button window sends a WM_COMMAND message to the dialog box window. The DID_OK identifier is encoded in the message parameters that accompany this WM_COMMAND message. Control windows that don't send messages (such as the text strings) are given IDs of -1. The ID number is followed by four numbers that I'll discuss below. The identifiers WS_SAVEBITS

Fig. Dictable w. S. AV (2011).

Fig. Dictable property of the property of the

DIALOG BOX COORDINATES Each line in the dialog box template includes four numbers that follow the window ID. These four numbers define the position and size of the window.

The first two numbers represent the position florizontal, followed by vertical) of the lower left corner of the window, relative to the lower left corner of the window's "owner." The owner of the dialog box window is the client window of the program. The owner of each of the control windows is the dialog box window. The second two numbers indicate the width and height of the window.

(Some people—myself included—don not like positioning the dialog boxes with reference to the lower left corner of the windows. In Microsoft Windows the position was based on the upper left corners of the window. It's possible that Microsoft will change this before the retail release of the Presentation Manager.)

Dialog box templates employ their own unique coordinate system. The horizontal

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coordinates and sizes are defined in units of 1/4 the width of a "system font" character. The vertical coordinates and sizes are 1/s the height of a system font character. The system font is the font that the Presentation Manager uses for all normal text, such as the text in title bars, menus, and dialog boxes. When a program displays text to its window, the default font is the system font

Why base coordinates and sizes on the system font? The reason is that Presentation Manager programs must be able to run on every video output device supported by the Presentation Manager. These output devices may have very different horizontal and vertical resolutions, and this will be reflected in the size of the system font character. Basing dialog box positions and sizes on the system font ensures that the dialog box will look about the same regardless of the resolution of the video display on which the program is running. This is part of the "device-independent" nature of Presentation Manager programming.

In the DIALOG statement for the first dialog box in BOXES3.RC, the four numhers are

10. 100. 160. 96

Thus, the lower left corner of the dialog box window will be positioned 10 units (or 21/2 characters) to the right of the left edge of the program's client window, and 100 units (or 121/2 characters) from the bottom. The window is 160 units (40 characters) wide and 96 units (12 characters) high

The first CTEXT statement uses the four numbers

18. 74. 148. 18

The lower left corner of this window is thus positioned 10 units (21/2 characters) from the left of the dialog box and 74 units (91/4 characters) from the bottom. It is 140 units (35 characters) wide and 10 units (11/4 characters) high. The text string is horizontally centered within the window.

COMING UP In the next issue, I'll finish this discussion by showing the other files required to create BOXES3, including the BOXES3 C file. We'll see how a Presentation Manager program displays a dialog box, initializes it, and processes messages from the dialog box controls. 22

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Ouicksort is one of the best general-purpose sorting algorithms available. Presented here are both an explanation and a practical C implementation.

there are times when programming in a high-level language has its advantages. One of those times is when you've got an array of data to sort. It's nice to be able to leverage off the expertise of some programmer who got paid to research sorting techniques, write a library sort routine, and then tune it until there were no cycles left to shave.

Standard C libraries include an exceptionally powerful and general sorting routine called asort. It is an implementation of a particular sorting algorithm called Quicksort, which I'll discuss more fully below. The quort routine has four parameters: the base address of an array of data, the number of items in the array, the width (in bytes) of each item, and the address of a function that can compare two data items of the type contained in the array and return a signed value as follows:

```
<0
     if n1 < n2
     if n1 = n2
>0
     if n1 > n2
```

Thus, quort can be thought of as a sorting "engine." If you're using one of C's native data types, you can usually construct an appropriate comparison function in a few lines of code as shown in Figure 1. In the case of strings, the standard library function stremp is perfectly suited for use with asort. Even if you are not using a native C data type, gsort couldn't care less; as long as you know enough about the data representation to tell whether one item is "smaller" than another, you're in busi-

Figure 2 demonstrates the use of quort. It prompts you to enter from 1 to 25 strings, sorts them, and then displays the sorted list. Press the Enter key alone at the string #1 prompt to exit from the program. An empty line entered at any other prompt triggers the program to start sorting.

ALL SORTS OF SORTS A glance into any algorithm textbook will soon have you shaking your head as the professors debate

their performance, and the types of data for which they are best and worst suited. These are very relevant issues, of course, since they translate into computing time. and that time costs money. But sorting techniques are the province of mathematicians and computer scientists, and these fellows don't usually write in a style that's very accessible to us casual programmers. There are many kinds of sorts described

the pros and cons of sorting algorithms,

```
int compare(int *n1, int *n2)
     if(*n1 < *n2) return -1;
                                          /* if n1 < n2 return -1 */
/* if n1 = n2 return 0 */
     return(*n1 > *n2):
                                          /* if n1 > n2 return 1 */
```

Figure 1: A routine to compare two integers used with asort.

```
TRYQSORT.C Demonstrates use of the library
                 routine "quort" to sort strings.
    Ray Duncen * PC Hagazine May 1988
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#define ITEM LENGTH 88
                                        /* mex string length */
/* max number of strings */
#define N ITEMS
                                         /* strings stored here */
static char items[N ITEMS * ITEM LENGTH];
main(int arge, char *argv[])
    int i, j;
                                         /* some scratch variables */
    while(1)
                                         /* get strings & sort them */
```

The TRYQSORT.C program shown in Figure 2: The TRYQSORT.C program uses qBort to sort a set of strings entered by the user.

■ POWER PROGRAMMING

```
puts("\nEnter strings to be sorted..."):
                             /* initialize string count */
while(i < N_ITEMS)
                             /* enforce maximum entries */
    printf("%2d: ", i+1);
                             /* prompt user */
                             /* read the keyboard */
    gets(&items[ITEM_LENGTH ' i]); /* last entry if empty line */
    if(items[ITEM LENGTH * i] == 0) break;
    i++:
                             /* bump string counter */
if(i--0) exit(0):
                             /* if no strings exit */
                             /* sort the strings */
qsort(items, i, ITEM LENGTH, stremp);
puts("\nHere are the sorted strings...");
= 0;
                             /* initialize string counter */
while (j < i)
                             /* display sorted strings */
    printf("%2d: %s\n", j+1, &items[ITEM_LENGTH * j]);
                             /* bump string counter */
                                                   (Figure 2 ends)
```

in the computing literature: selection sort, insertion sort, bubble sort, Shellsort, Quicksort, radix sort, Heapsort, Mergaort, and so on. The simpler and more-obvious methods, such as the inflamous bubble sort, are the once that self-trained programmers hit on "intuitively." These also tend to have the worst performance unless they are used on just the right data sets, because they involve the most comparisons of the data movement.

The really powerful sorts, which perform well for all kinds of data, have been invented (or discovered, depending on your point of view-did Einstein invent or discover the law of relativity?) by a very few people who have an extraordinarily deep understanding of information theory. mathematics, and digital computers. These people are fascinating because their work is extremely abstract, yet supremely practical. It's abstract because a new sort algorithm may come from a pure flash of insight and does not correspond to anything previously existing in the real world. But it's practical because such an algorithm can be implemented, tested, and put to useful work immediately.

Quicksort is an interesting example. It was invented in 1960 by C. A. R. Hoare, one of the pioneers and legends in computer er science (and, incidentally, one of the most determined critics of Ada). It has been analyzed in great detail and is the sub-piect of many book chapters, journal articles, and (no doubt) graduate student theses. Outleksort is an excellent general-

purpose sorting technique to add to your bag of tricks: it works in place, it works well on all kinds of data, it is easy to implement, and it is well suited to languages (like C) that support recursion. And it's very unlikely that you would have thought of it on your own.

The parameters "left" and "right" define a subset of the data to be sorted. Let us assume that the data is in an array and that "left" and "right" are simply indexes to

Figure 3: The Quicksort algorithm as implemented in C. that array. The entire data set can then be sorted with the call

quicksort(0,N-1)

where N denotes the number of items in the

To quote Dr. Sedgewick: "The crux of the method is the partition procedure, which must rearrange the array to make the following conditions hold:

"1) the element array[i] is in its final place in the array for some i. "2) all the elements in array[left] . . .

array[i-1] are less than or equal to array[i].

"3) all the elements in array[i+1]

"3) all the elements in array[i+1] . . . array[right] are greater than or equal to array[i]."

In other words, Quicksort is called (either by some other procedure, or by itself) with a couple of pointers that define the be-

Quicksort is an excellent general-purpose sorting technique to add to your bag of tricks. And it's very unlikely that you would have thought of it on your own.

ginning and end of a set of data. It picks an arbitrary member of that set around which to partition the rest of the set. (For simplicity, in this version it just picks the last or rightmost member of the set.)

Quicksort then rearranges the data set so that all of the members that are less than the partitioning value lie to its left, and all the members that are greater than the partitioning value lie to its right. This is done fluid in the members that are greater than the partitioning value lie to its right. This is done fluid in the partitioning value lie to its right. This is done fluid in the left and the data set to the data set to the right attent as the the right data set to the right and the partitioning item. With this divide-and-conquer approach, it eventually great, it eventually great to to data sets in which there is nothing to do.

The OWIKSORT C demonstrate.

```
MINSORT.C Simple implementation of Quicksort
in C. sorts an array of numbers.
     Ray Duncen . PC Magazine May 1986
                                                                                                               Quickmorta en array of integers, recursing to sort subsets
of the array. Called with the index to the left and right
members of the array to be sorted.
#include <atdio.h>
#include <atdlib.h>
#define N_ITEMS
                                                       /* size of errey */
static int items[N_ITEMS];
                                                        /* numbers to be sorted */
                                                                                                         void quicksort(int left, int right)
woid quicksort(int, int)
                                                       /* function prototype */
                                                                                                                                                                /* some scratch veriables */
                                                                                                               int i, j, t;
mainting area char secont to
                                                                                                               if(right > left)
                                                                                                                                                                /* akip unnecessary calls */
     int i, j;
cher buffer(60);
                                                      /* some scratch variables */
/* some scratch space
for keyboard input */
/* get numbers & sort them */
                                                                                                                                                                /* initialize scan pointers */
                                                                                                                      i = left-l; j = right;
                                                                                                                                                                /* partition errsy on Value
/* of the rightmost item */
     while(1)
                                                                                                                     do {
            puts("\nEnter numbers to be sorted
                                                                                                                                                                /* scen right for item >- */
/* then pertitioning value */
                                                       /* initialize array index */
/* enforce maximum entries */
            while(i < H ITEMS)
                                                                                                                           do 1++
                                                                                                                                  while(items[i] < items[right]);
                 printf("%2d: ", i+1);
                                                       /* prompt user */
/* read the keyboard */
                                                                                                                                                                /* scen left for item <- */
/* then partitioning value */
                                                                                                                    do j--;
    while(items[j] > its
    t = items[i];
    items[i] = items[j];
    items[j] = t;
) while(j > i);
                  geta(buffer);
                 if(buffer(#) == # ) break;
/* convert ASCII number to
                                                        /* last entry if empty line */
                                                                                                                                                                ems[right] 44 j > 0);
/* interchange the items */
                                                            binary and have it */
                  items[i] = atoi(buffer);
                                                                                                                                                                /* do until pointers cross */
                                                       /* bump array pointer */
                                                                                                                                                                /* undo the lest awap end */
/* put the partitioning */
* element into position */
/* act items to left of */
/* partitioning element */
/* act items to right of */
            }
if(i==0) exit(0);
quicksort(0, i=1);
puta("\nHere ere the sorted
                                                                                                                     itema[] = itema[i];
items[i] = items[right];
                                                       /* if no numbers exit */
                                                                                                                      quicksort(left, i-1);
                                                       /* initialize array pointer */
/* display sorted numbers */
              hile (j < i)
                                                                                                                     quicksort(i+1, right);
                                                                                                                                                                 /* partitioning element *
                  printf("$2d: $d\n", j+1, itema[j]);
1++: /* bump array pointer */
```

Figure 4: The demonstration program QWIKSORT.C, the source code for a simple implementation of Quicksort in C.

end up in one subset.

program listed in Figure 4 contains a simple implementation of Quicksort in C. Similar to the Figure 2 program, QWIK-SORT prompts the user for some numbers. sorts them, and displays the results of the sort. You can insert printf statements at appropriate places in the Quicksort routine to display the contents of the items array and get a feeling for what is going on during the sort. An example of a session with such an "instrumented" program is found in Figure 5.

OPTIMIZATIONS How could this Quicksort implementation be improved? The fundamental algorithm is very efficient as it stands because the inner loops are simple increments and comparisons. It's hard to see how you could shorten up these loops, and even the stupidest compiler can successfully generate good code for them

One obvious target for optimization is the strategy used for selecting a partitioning value. In our example, we simply used the rightmost element; this is a reasonable strategy when the data is very disordered. since "on the average" it comes up with a 1 stutements that display extra information.

partitioning value that is "in the middle." When the data starts out nearly sorted, though, using the rightmost element is a very bad strategy. This is because each time the data is partitioned most of it will

Other possible optimizations include use of a "goto" when the pointers cross to eliminate the final unnecessary exchange (which has to be restored), and eliminating recursion from the algorithm. If you are in-

terested, you can read much more about these topics in Chapter 9 of Sedgewick's book and try the optimizations out for vourself. BIBLIOGRAPHY FOR SORTING

Here are some well-respected texts on sorting algorithms. Sedgewick's book is especially recommended. ■ Algorithms, 2nd edition, by Robert

Sedgewick, Addison-Wesley Publishing Co., Reading, Mass., 1988. ISBN 0-201-06673-4 ■ Algorithms + Data Structures = Pro-

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Art of Computer Programming), by Donald Knuth. Addison-Wesley Publishing Co., Reading, Mass., 1973.

THE IN-BOX Please send your comments and suggestions to me at any of the following e-mail addresses: PC MagNet: 72241,52 MCI Mail: Imi BIX: rduncan

```
Enter numbers to be sorted...
      centers
      <Enter>
      (Enter)
      (Enter)
     <Enter>
    <gnter>
left:
                            6 5 4 3 2 1
         right.
                     streys
left:
         right:
                     errevi
left
                     errey:
         right
Sorted errey: 1 2 3 4 5 6
Total quicksort cella: 5
```

Figure 5: A sumple session using OWIKSORT.C with added printf

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SPREADSHEET CLINIC



Changing range dimensions easily; handling divide by zero errors in SuperCalc; pausing a macro to do other work; eliminating extra form feeds for worksheets with hidden columns.

Avoiding extra page feeds when printing 1-2-3 worksheets with hidden columns

I found a bothersome bug while working with a workshet that simply contained one column for each month of 1988. As it was early in the year, all but the first few columns of the workshet were blank, except for the column headings. To avoid having to alter the print settings each month, 1 set the print range to encompass all of the columns in the model and used the I'Worksheet Column like command to hick all the time first two, data-filled col-line and the first two data-filled col-line and the first two, data-filled col-line and the first two data-filled col-line and the filled col-line and the filled col-line and two data-filled col-line and the filled col-line and the fill

After setting the print range and hiding the "unused" columns, I found that although I-2-3 printed the range and hid the entires in the hidden columns specified, it then beeped and scrolled through an extra blank page. When I printed longer worksheets, the program scrolled through additional blank pages.

Checking this out, I found that hiding the rightmost column of the print range was the culprit. If I reduced the print range to exclude the hidden columns, or if I middle the hidden columns, or if I middle the print range. 1-2-3 printed the worksheet without beeping or spitting out blank pages. —Mark Justice Hinton; Albuquerque, New Mexico

Lotus 1-2-3 has problems when you hide the rightmost column of a print range. Since you can't point to a hidden column when you define a print range, however

you won't encounter this bug unless you hide a column after specifying the print range. Fortunately, most people usually perform these steps in the opposite or-der—they hide columns, then they set the print range. If you do encounter the problem, you can solve it either as Mr. Hinton suggested, or by expanding the print range to cover a blank column to the right of the hidden column.

The {Get} command provides a better way to create a pause in macro execution

In the January 26, 1988, Spreadsheet Clinic, Ralph D. Sappe correctly pointed out that using {?} to pause a macro gives the user freedom to do things other than what the programmer intended during the pause. To avoid improperly entered keystrokes, Mr. Sappe suggested following the {?} command. Although this does help in many situations, it does not always work.

The [Get] command provides a more to footproof method of creating a pause in a macro. When 1-2-3 executes a (Get) command, it halts the execution of the macro until the user presses any key. At that the until the user presses any key. At that clients the macro representation of that key into the cell specified by the argument of the [Get] command, then resumes the execution of the macro. For example, Mr. Sappo suggested us-

ing the statement

(Goto) MESSAGE" (?) /xqRESUME"

to pause a macro while the user read the message in the cell named MESSAGE. I would instead assign the name KEY to a cell in the worksheet and use

(Goto)MESSAGE (Get KEY)/xgRESUME

When 1-2-3 executes this statement, it moves the cell named MESSAGE and pauses until the user presses any key. When he does, 1-2-3 stores the macro representation of that key in the cell named KEY, then branches the macro execution to the cell named RESUME.—Robert F. Brooker, Ph.D.; Eric, Pennsylvania

The (Get) command provides a safer way to pause a macro than (?). However, the (Get) command is only available in 1-2-3, Release 2 or later. Thus, users of Release 1A are stuck with the less desirable (?) (Esc) approach.

Building an @DATE function on the Edit line makes it easy to convert six-digit labels to serial date values

In the January 26, 1988, Spreadsheet Clinic, Robert Dimond used a mathematical formula to convert six-digit labels in the form symmdd into serial date values. You suggested that users of 1-2-3. Release 2, use a formula that employs the @ DATE, @VALUE, @LEFT, @ MID, and @RIGHT functions.

Although these methods work, I prefer an alternative technique that builds an @DATE function around the entry on the

■ SPREADSHEET CLINIC

```
A B C D E F
1 \d {Edit}{Rome}{Del} {Edit}
6 BOATE({Right},{Right},{Right},{End})
3 {Calc}^-
4
```

Figure 1: This 1-2-3 macro converts date labels into serial date values.

Edit line. This method replaces each label with a serial date value, instead of entering the value into a serarate cell.

The first statement in the macro shown in Figure I brings the date label to the Edit line, moves the cursor to the left edge of that line, and deletes its label prefix. The data line, and deletes its label prefix. The the left of the six digits on the Edit line), processed the Right like y twice (moving the cursor to the right of the year component in ext moves the cursor to the right of the month component and tops a comman. I most moves the cursor to the right of the month component and tops a combine comman. On the right of the most moves the cursor to the right of the most moves the cursor to the right of the most moves the cursor to the right of the day component and tops a cloning parenthesis.

At this point the Edit line contains an of nOATE formula that will return the serial date value of the label date in the current cell. If the current cell contained the label 'S81124, for example, the formula of NOATE(S81,124) would appear on the Edit line. The final statement in the macro process the Calle key, which replaces the formulas with its current result. In the experiment of the comment of the contraction of the comment of the contraction of the thin the contraction of the

This technique is a good alternative to those presented in that January 26, 1988, Spreadsheet Clinic. If you need to convert a column of entries, you may want to add a {Down} command or a {Down}{Branch \u00e4}; combination to the end of the macro.

Using the period key to change the cell coordinates in 1-2-3 worksheets

Whenever you highlight a range within a 1-2-3 worksheet, its coordinates are displayed in XX..YY form at the top of the first in this reference is the anchor cell; the cell whose address appears last is the free cell. 1-2-3 always marks the free cell with an underline cursor.

If you press the period key while a range is highlighted on the screen, 12-3 will change the positions of the anchor and free cells. Each time you press this key, 12-3 moves the anchor and free cells one corner at a time, and usually in a clockwise direction. For example, if you press the period key while cells B2. D4 are highlighted and the cursor is need D4 (including that cell D2 is the anchor cell and clocking that cell D2 is the anchor cell and causer to cell B4, making it the free cell and making cell D2 the anchor cell.

Moving the cursor around a range allows you to expand or contract the range from any of its four sides. When you press the Right, Left, Up, or Down Arrow keys while a range is highlighted, 1-2-3 expands or contracts the range from a side opposite to the comer containing the anhor cell. That is, it expands or contracts the range from a side adjacent to the comer the range from a side adjacent to the comer that contains the free cell.

Suppose, for example, that you have assigned the name TEST to cells B2...D4 and now want that name to apply to cells A1...D3. To change the coordinates of this

range, you would begin by issuing the Range Name Create command, selecting the Range Manne Create command, selecting 1,2-3 would expand the highlight to cover cells 82. D4 and position the cursor in cell B4. At this point, you would press the Up key to contract the range so that it covered only cells 82. D3. Next, you would press the period key twice, moving the cursor to cell B2. Then, you would press the Left and Up Arrow keys once each to expand the range to cover cells A1. D3. Finally, you would press to the range to cover cells A1. D3. Finally, you would be flatter to lot in the new cover. Columbox, Office.

This is one of the most useful 1-23-tips you'll ever get. Although this use of the he period key is documented, many 1-2-3 use or the they is documented, many 1-2-3 use or are not aware of it. Even fewer know that you can use 60 CELLPOINTER functions to extract information from the cells in the corners of a highlighted range. If 1-2-3 evaluates an 60 CELLPOINTER function while a range is highlighted, it will draw information from the free cell of

the range.

The mucro shown in Figure 2 uses this technique to determine the addresses of the cells at each of the four corners of a needle at each of the four corners of a men of the range whose corners you want to locate. When you type in a name and personal packed that the properties of the prope

```
CGLIAbel TRIGE a range names "ADAGGEMANY
CAT DEPARTMENT ("Address"))
Let DOTTOMERT, GELLFOURTER("address"))
Let TOPLET, GELLFOURTER("address")
Let TOPLET, GELLFOURTER("address"))
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MANGERMAN
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■ SPREADSHEET CLINIC

light the range to which the name RANGENAME is assigned and to position the cursor on its lower-right cell.

At this point, 1-2-3 executes the series of {Let} statements in cells B3..B9. Since the cursor is on the lower-right cell of the range when 1-2-3 evaluates the first {Let} statement, the program enters the address of that cell into the cell named BOTTOM-RIGHT (B16), Next, 1-2-3 presses the period key, moving the cursor to the lowerleft cell of the range. At that point, 1-2-3 executes the second {Let} statement. which enters the address of that cell into the cell named BOTTOMLEFT (B17). The program then presses the period key again, moving the cursor to the upper-left cell of the range. It then evaluates the {Let} statement in cell B7, which enters the address of that cell into the cell named TOPLEFT (B14). In a similar way, the statements in cells B8 and B9 move the cursor to the upper-left cell of the range and enter the address of that cell into the cell named TOPRIGHT (B15).

Finally, 1-2-3 executes the statement in cell B10, which completes the / Range Name Create command, locking in the original coordinates of that range. To illustrate: if you typed in the range name TEMP in response to the {GetLabel} statement in cell B1, and the name TEMP was assigned to cells H5..J10, 1-2-3 would enter the label '\$J\$10 into BOTTOMRIGHT, the label 'SHS10 into BOTTOMI FFT the label 'SH\$5 into TOPLEFT, and the label '\$J\$5 into TOPRIGHT.

A SuperCalc bug lets you return a 0 value instead of ERR when you encounter an illegal division by 0

In the Spreadsheet Clinic of September 15, 1987, you published a technique that involved using an @IF function and an @ISERR function to make 1-2-3 return the value 0 instead of the value ERR when it divides a value by 0. For example, if cell All contained the value 50 and cell Bl contained the value 0, the formula + A1/B1 would return the value FRR. The function

@IF(@ISERR(A1/B1), 0, A1/B1) would return the value 0, however.

way to achieve this result. Instead of dividing one value by another, you can multiply the two values after raising the second one to the -1 power. Thus, to divide the value in cell Al by the value in cell B1, you would use the formula +A1*B1'-1. When SuperCalc evaluates this formula, it begins by raising the value in cell B1 to the - I power. This should be equivalent to dividing I by that value: if cell B1 contained the value 2, this portion of the formula

For some reason, SuperCalc breaks the rule when the referenced cell contains the value 0. When SuperCalc evaluates the expression 0"-1 it returns the value 0-not the value ERROR. Consequently. SuperCalc returns the value 0 when you use this method to divide a value by 0

would return the value 1/2.

In either case, SuperCalc multiplies the result by the value in cell A1. If cell B1 contains a value other than 0, the formula +A1*R1*-1 will return the same result as the formula +A1/B1. If cell B1 contains the value 0, however, the formula + A I/R1 will return the value FRROR but the formula +A1*B1*-1 will return the value 0.-Dionisio Othon: Hermosillo. Sonora, Mexico

This is one of those rare instances in which a bug has beneficial results. Unless you use negative powers for some reason other than as explained above, your worksheets won't be adversely affected by the incorrect way SuperCalc evaluates formulas that raise 0 to a negative power.

Unlike SuperCalc, 1-2-3 evaluates the formula + CELL -1 correctly in all cases. If CELL contains the value 0. 1-2-3 will return the value ERR-the same result it would return for the formula 1/CELL. Consequently, this alternative technique will not work in 1-2-3.

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User-to-user

Using the DOS redirection facility to your advantage; a neat technique for incorporating local subroutines in your batch files: a better way to change directories.

Incorporate local subroutines in your batch files by using the DOS environment

I have found an easier way to use subroutines in a batch file by using the environment space of DOS. In the example batch file shown in Figure 1, I make use of the section labeled SUBROUT three times, by setting the DOS environment variable Pl and using the GOTO command. This technique has proven very useful, as it saves me from having to invoke COM-MAND.COM to run a subroutine.-Colin R. Sledge: Dallas, Texas.

This is a great way to take advantage of replaceable parameters and makes good use of the DOS environment.

The environment consists of a series of character strings in the form VARIABLE =VALUE. In most cases the environment will consist of at least three of these strings, COMSPEC, PATH, and PROMPT. Additional strings can be entered into the DOS environment using the SET command. The SET command can also be used to display the current environment by just entering SET with no parameters

DOS environment variables are accessible within a batch file by surrounding the variable name with percent signs. So, for example, on my machine ECHO ECOMSPEC% from within a batch file displays C:\COMMAND.COM. As shown in the example in Figure 1,

subroutines can be written that return con-

```
ECHO In the mainline batch routine ...
SET P1=MD1
GOTO SUBROUT
:MD1
ECHO In section MD1 ...
SET P1=MD2
GOTO SUBROUT
ECHO In section MD2...
SET P1=MD3
GOTO SUBROUT
ECHO In section MD3...
GOTO FINISH
:SUBROUT
ECHO
ECHO In the subroutine ...
ECHO
```

ECHO This batch file has finished Figure 1: Using environment variables for subroutine calling in batch files.

trol to the label specified in an environment variable.

GOTO %P1%

:FINISH

SET P1=

Using this technique, batch file subroutines can be called without having to invoke a secondary command processor. Additionally, since the subroutines no longer have to be stored in separate files, each taking up at least one cluster of disk storage, this technique helps save disk space. - Salvatore P. Ricciardi

Speed up repetitive tasks using the DOS redirection facility

I recently had to process 36 files for conversion to another format. I came up with a way of using the DOS redirection capability to make the task easier. First, I performed a DIR on the files, re-

directing the output to a text file (for exam-

■ USER-TO-USER

ple, DIR ??.DBF > DIR.TXT). Then I edited the file into the series of commands that I would have otherwise had to enter. Then I entered

COMMAND < DIR.TXT

The conversion utility dutifully changed each file to the desired format, bringing me back to the DOS prompt when all 36 had been processed.—Joseph E. Burnside III: Alexandria, Virginia

Unless the very last line of such a file is EXIT followed by a carriage return, you'll be stuck in a secondary command processor that won't take keyboard input. If you experiment with this technique, don't forget the EXIT!

It is an interesting subject for experimentation. Any programs called in your command script that get input from standard input (i.e., are redirectable) will also expect input from the file. This makes it REN FILENAME.EXE FILENAME.DBG DEBUG FILENAME.DBG (insert debug commands here)

REN FILENAME.DBG FILENAME.EXE

Figure 2: Example script for COMMAND to patch an .EXE file.

possible to, for instance, write a command script that will apply a DEBUG patch to an EXE file (see Figure 2). And DOS doesn't have to open and close the file for each line the way it does for a batch file.—Well J. Rubenkins

Productivity Tip

To put a nonprinting comment line in a batch file, put a colon in front of it. It will be treated as a label.—Neil J. Rubenking

MASTER SWITCHS

Change directories faster without searching for the Backslash key

The Backslash key is in a different place on every computer I use. This makes changing directories a maddening exercise in hunt-and-peck. I now use TO.BAT instead of the DOS CD command. It accepts directory names separated by spaces rather than backslashes. Type the following two lines into the file named TO.BAT:

GECHO OFF FOR SEX IN (\ S1 S2 S3 S4) DO CD SEX

To change to the directory \TOOLS, type
TO TOOLS. To change to \PETER\LTRS,
type TO PETER LTRS. To change to the
root directory, simply type TO.

TO.BAT uses the FOR command to feed directory names to the CD command. This makes it fast, even on a 4.77-MHz XT. Without FOR, TO.BAT would need





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■ USER-TO-USER

many IF statements and would be considerably slower.

The FOR statement that changes directories contains enough parameters to handle four levels of subdirectories. If you need more, just add them. This will not slow down TO.BAT. Regardless of how many batch file parameters you have, the FOR statement stops when it runs out of real command line parameters.

With DOS 3.3, TO.BAT won't clutter up your screen at all. If you have an earlier version of DOS, you will need to remove the @ before ECHO OFF. In this case, TO.BAT will display ECHO OFF each time you use it.—Peter A. Klein; Seattle, Washington

Unlike CD, the example TO.BAT always starts with the root directory. To make TO act more like CD, eliminate the backslash in the FOR list as follows:

FOR %%X IN (%1 %2 %3 %4) DO CD %%X

The FOR statement is quite powerful, you can use it nick bath files c directly at the DOS command line. If you use it at the command line, the FOR variable mast have one % no two. You can put multiple ambiguous filespees (with wildcards) in a POR list. This makes it easy to write batch commands that take a list of arguments. The batch file shown in Figure 3 deletes files matching any of up to nine filespees. For example, MULTIDEL * BAK * OLD

* . \$\$\$ TEMP . * will delete files matching any of the four filespecs.—Neil J. Rubenkine

Productivity Tip

To see a file one screenful at a time, use the DOS command MORE. For example, MORE < A. TXT.—Neil J. Rubenking

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REM MULTIDEL.BAT

ECHO OFF FOR %%f IN (%1 %2 %3 %4 %5 %6 %7 %8 %9) DO DEL %%f

Figure 3: A batch file that deletes files matching up to nine filespecs.



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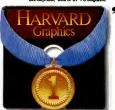


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POWER USER



Tips to initialize dBASE memory variables, print a display screen from inside dBASE III Plus, speed up glossary entries in Word, and SUM and COUNT simultaneously in dBASE.

Speed up glossary entries in Microsoft Word using nested macros

Normally a text-only glossary entry of almost any size will feed into a document in Microsoft Word so quickly that speed is not an issue. But if you include even a single macro command in the entry, the speed of text entry slows down drastically. As an example, a six-line paragraph that Word normally enters too quickly to time takes over 17 seconds on an AT if you add a

<tab> command at the beginning.

Fortunately for those who mix text and commands, Word's 'nested macros' feature provides a way out. Simply put the text in its own glossary entry, TEXT, and call up the glossary entry from the first macro. For the single-paragraph example with a
 cabo command added, give the name TEXT to the text portion and write the macro as

<tab><esc>itext<enter>

As long as the nested macro contains nothing but text, the entry speed will match what you would normally expect.

Of course this is a frivial example, stripped down to basics to demonstrate the technique. Actual applications would include standard forms that are recorded in a macro, consist mostly of text, but pause occasionally for input from the keyboard—as with a memo format.—Robin Schlaff: Chappaqua, New York

This is a nice point indeed. Note, too, that you can nest more than one macro within a

single "master" macro. For example, here's a macro for automatically formatting the first page of a manuscript:

<ctrl-esc>ihesd1<enter><esc>fpc<enter><nsuse.<enter><esc>ihead2<enter><de1>

The first nested macro, HEAD1, should include everything that goes above the tite. The macro pauses in order to let you fill in the title. The second nested macro, HEAD2, adds the "by" line and your name.—M. David Stone

A dBASE command that saves time by SUMing and COUNTing in a single pass

I've found a useful way to overcome difASE's inshifty to SUM and COUNT at the same time. If you want to know the average sale price of a particular product in a sales database, for example, you need to asles database, for example, you need to transactions. In dBASE you must SUM the price field for that product in one command, then COUNT the records for the product in a second pass of the first.

With large databases, this dual procedure is time-consuming. However, you can cut down the time by using this simple technique. If, for example, your price field is named "price," the dBASE command

SUM price, 1 FOR product="Widget" will yield both answers at once.—Richard Grossman; San Pedro, California

For another variation on Mr. Grossman's

creative technique, see the letter from Robert Marcus in our November 24, 1987. Issue. Jrv. Marcus uses dBASE's bulli-in report form generator instead of the interactive command above. The interactive command is faster, and you needn't creative command is faster, and you needn't create are port form. FRM file first. On the other hand, Mr. Marcus's approach can generate far more numbers in a single pass of the file, and it also produces a nicely formatted result.—Brad Sarting.

A simple program to print the current screen automatically from inside dBASE III Plus

PRINTSCR.BIN provides a simple way to print the user's display screen from inside a dBASE III Plus program. It can be used to create a report that is as flexible as a screen, or it can be offered as a menu choice. Just make sure DEBUG.COM is on your path and enter

debug n printscr.bin e 100 cd 05 cb

w q

d Then, in your dBASE program, issue the commands

LOAD printscr CALL printscr RELE MODULE printscr

whenever you wish to print the screen.—Chris Allen; Coloma, Michigan



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other popular laser printer. Ask for Avery Laser Printer Labels (Product code #'s 5160 through 5165) wherever computer and office supplies are sold. Or call 1-800-535-3232 ext 30 for a free sample pack or the dealer nearest you.

■ POWER USER

Hitting Shift-PrtSc to print a screen image is easy enough in most cases, but this routine provides the capability of issuing this command from inside a program-either automatically or from a menu. This routine also overcomes the limitation imposed by some programs that shut off the Shift-PrtSc key combination in case the user hits it by accident, Finally, PRINTSCR.BIN can be used while debugging to keep a record of a program's process.-Brad Stark

A WordPerfect macro that displays a file directory as the initial screen

I rarely want to begin with a screen looking like a "blank sheet of paper," so Word-Perfect's opening blank screen is somewhat bothersome. My solution is to define a startup macro that does a "list files" when the program loads. I can then quickly retrieve the existing file I want to work on. However, in the event that I really do want a blank sheet, tapping the Spacebar brings up a blank screen.

I keep my WP software in a subdirectory called WP and my documents in WP\FILES. You'll have to adjust the macro to fit your particular file setup. Enter the keystrokes below to create STARTUP MAC

200 VI-9165 <75>=\N7\TILES<CR> <CB3 <Ctrl-F18>

Begin mecro def. Cell it STARTUP CD to \WP\FILES List current dir. End mecro def. Now edit your AUTOEXEC.BAT file,

adding this line: SET WP=/M-STARTUP

Reboot so the new AUTOEXEC takes effect and start WordPerfect as usual. You will come up in the "list files" screen ready to begin work .- Robert S. Kaplan; Fairfax Station, Virginia

You can use this technique to make any macro execute automatically upon starting WordPerfect. If you don't want it to happen every time, you can omit the SET step and enter the command

WP /M-STARTUP

to invoke WordPerfect from the DOS prompt.-Neil J. Rubenking

A technique to initialize tencharacter dBASE memory variables

Fred Wampler's tip, "Initializing dBASE Variables" (Power User, October 27, 1987), is very useful, but it does not allow the use of ten-character field names. This can be a problem-especially if the first nine characters of several different fields are identical. Fortunately, the folks at Ashton-Tate

have provided a solution by allowing memory variables to have the same names as fields. The field name takes precedence. but you can force dBASE to select the memvar by using the m-> alias. For example, suppose you have a field called FIRST_NAME:

first name=first name *initialize memorr with field contents

REPL first name WITH first name *REPLace field with itself (wrong) REPL first name WITH n->first name

Using the REPLace syntax above, and simplifying the "?" command in Mr. Wampler's routine with the line below, al-

names.

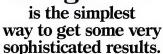
lows you to use all ten characters for field ? "STOR", &x, "TO", field name *initialize memvar of That name

-Timothy M. Snyder: Glenside, Pennsylvania

This will do the trick for ten-character field names, though many programmers avoid field names longer than nine characters because you can't access them with a macro. Further, it takes dBASE longer to

Here's a puzzling spin-off. Mr. Snyder is right that whenever a symbol name is used in a program, dBASE searches first in that part of memory that holds the field names of the current database. If not found there, the program looks elsewhere to see if you are referring to a memvar. By specifying the m-> alias you'd think the program would run faster, since it needn't search the field name list. But no. In testing dBASE, FoxBASE, Clipper, and DBXL, I found that specifying the m-> alias actually took a bit longer. The explanation for the slight slow-

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down is that using the m-> alias changes the symbol name from a direct reference into an expression that must be parsed first, and this takes longer than searching durough the field list. It follows that using any unnecessary alias will slow the program's operation—Brad Stark

Executing macros faster in Microsoft Word with SuperKey

Microsoft Word macros are nice to have. but they are somewhat slow in responding. For those macros where response time matters (cursor movement, for example), you can use SuperKey instead. With SuperKey loaded before Word, SuperKey will monitor your keystrokes, interpreting any that have been defined as macros in SuperKey and passing all others on to Word. You can even give the same key macro definitions in both Word and Super-Key without problems. If SuperKey is loaded, you will get the SuperKey macro when you type the key. If it's not loaded. or if you use the backquote (skip command) before typing the key, you will get the Word macro.-Mike Pandolfo: Maspeth, New York

The only problem you will run into with Super/Key loaded is that you won't be able to use the Alt-Key and numeric keypad to enter the high-order characters. But you can get around this by calling up the Super-Key menu and typing OU (Options \$15)pend). When you're done, use the Escape Library Run command in Word to give the command

KEY /OU

to turn the suspend option off again. Even better, put the command in the following macro:

<esc>lrc:\SuperKey\key /ou<enter>
This macro assumes that SuperKey is on drive C: in the directory SuperKey. Call it SKEYON. Then, when you want to turn SuperKey back on, type

SKEYON <F3>

Word will give the command automatically, and you will be returned to your document.—M. David Stone

Productivity Tip

You can speed up your work in WordPerfect by loading all of the programs into memory. Normally WP leaves about 120K of data files and overlays on the disk, but if you type "'/R" on the command line ("WP iR", for example) it will load them all into RAM.—Netl.J. Rubenkine

Productivity Tip

Ctrl-X ('X) can be substituted for any single character in WordPerfect searches. To enter it, press -V' X. The display will look something like

-> Srch: s^Xark

This would find "shark" or "spark," for example.—Neil J. Rubenking

Productivity Tip

The dBASE label generator allows a usually ample 60 characters to define each line, but if your expression involves IIF's and SUBSTR's, you can quickly run out of

A simple shortcut is to define a memory variable, S, as one space. In the example below (which should be entered as a single line), it saves ten spaces. Both LABEL and REPORT FORMS will accept memory variables, though dBASE will reject macros.

(s+pre)-(s+fn)-(s+ln)-IIF(suff>s,(s+suff),"")

-Brad Stark

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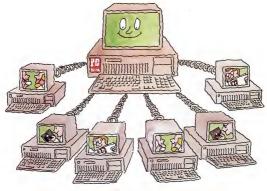
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GO PHONES at the 1 prompt.)

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		enter	

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Languages



A simple way to convert real numbers from 6 to 8 bytes in Turbo Pascal; passing Pascal procedures as parameters; copying files easily in QuickBASIC.

A smarter and faster method of copying files in QuickBASIC

I agree with Steve Greiner (Languages, October 13, 1987) that using the BASIC SHELL statement to copy files is less than ideal. However, the fact that BASIC cannot trap errors is the real problem. If an error does occur, DOS simply deposits an error message on the monitor and leaves BASIC cosled for disaster. If the user

chooses Abort, the program will crash and abandon any files left open. Mr. Greiner's FILECOPY. BAS is an acceptable approach, but execution time is roughly three times longer than that of DOS.

FILECOPY. ASM (Figure 1) adds fast, intelligent file-copying capabilities to the Quick BASIC arsenal. The program recognizes and reports all noncritical errors that might occur—invalid pathnames, source files that do not exist, read-only target files, and full disks. For simplicity. Quick-

BASIC maintains control of critical errors such as open drive doors.—Jonathan R. Conrad; Baltimore, Maryland

This is a fast and elegant solution to an otherwise messy problem. I've never been a fan of the SHELL command anyway because it has so many limitations. For starters, a QuickBASIC program that uses SHELL will hang when it ends unless DOS 3.0 or later is being used. Moreover, if COMMAND. COM isn't available, if COMMAND. COM isn't available,

FileCopy.ANK -	Copies Coar	e seurce file	ts o target file.		Nov Cto	87,[82-6] :	necesser from equipost error?
1) Assemble FileCopy.Asm to FileCopy.Obj 2) Disc BillClub to add FileCopy.Obj to Desplib.Eve			check Suffer:	How	91, (97+8)	; make ears buffer as big enough;	
2 2) the Bulldish to add FileCopy.Obj to DearLib.Ess 			20	Open Source	off se, then continue.		
Meter	Infile	- 00470	te peth and filename,		29·p	Close_Files	
				Open Segree:			
	Errcode						
		2 17	source file not franci () not used:		Box	00,191-21	15% - offset of Buffers
		6 11	source file is a directory	1	Boy	HI. (32+12)	(Point at to legiles.
			eource file not accessible		Now	6x.1	ithit errer code.
		6 17	target path not found	4	Call	Lord File	(Convert to ASCIIE,
		7.15	tarnet filename in townlid		BOT	AX. 30603	
			tarest directory is full		fet	21h	
		9.17	terget file is a directory		210	Open Tarest	abld an arrest negative
			terest file to read-only		cell	Find Ber	;If so, run the error enelysis.
			terest file not accessible		Je	fource trr	1 If Mr. error was found.
			length of Duffer\$ < 65 kytee	Bource_Err:	Jinp	closs_Files	
Secon			at be reprored with On Error,	Open Torquis	Box	Dource Sandle, AX	reave the ergre file bendle.
			th ErrCodet1 ofter critical errors.		BOT	EX, AX	: Here file handle to AX
			***************************************		Nov	AX,57045	190t time and date free courre
toda		eyte Public '			Push	DOX	rmave buffers eddress in DR
		CF:Code			Ie4	21.5	jeet source file's date and time
		FileCopy			BOT	File_Time, CX	I care then
					Nev	Pile Date, bx	; internally
Liscopy	7700	PHE			200	DIX	:Retrieve DE
egios	Jup	BEAUT	Lecel data follows:		Nov	HI, [HP+10]	(Point ni to OstFlles.
ource_Sundle	216				Mov	8X,6)Init error code.
Tergst_Hendle	DN				cell	Lord File	(Convert to ASCIII.
atter tire	DN				7601	AX, ICh	Request Creete/Clear File:
ytee Read	044				(64)**	CX, 6	: terget le normal file.
lle Time	DNE	7			tet	2131	2 do 15.
ile_bets	214	7			Jac	Ptep_Copy	itid on error occur?
met_Test	04	11),156			0+11	Tind Err	iff so, ren the error ensiyeis:
PAPE:	Park		I form of		30	Terget Err	; If CF, directory to full. ; If SF, error was found.
64641	No.	17.17	: core er.		Ton.	Techet att	1 II SF, SFFSE Wee Touns.
	Mov	87, 67 AX, DO			Tast.	AX.1	; Slee, if Nor cettribute AND 1).
	Mare	EE AX	Incire EE + DE.		7000	Terres Brr	Bise, if NOT (ettribute AND 1),
					Inc	Terget_Brr	: target is read-moly.
	20g	AX, 8X	place error code.	THEORY DEFI	200	Clese Files	

Figure 1: An assembler program to copy files quickly from within QuickBASIC.

■ LANGUAGES



Figure 2: The BASIC demo for using FILECOPY ASM.

SHELL will cause an Illegal Function Call error, which will befuddle most people using the program.

It is important to understand that if a DOS critical error occurs (open drive door, unformatted disk, etc.), then you must call FileCopy again to close any files that may still be open. Mr. Conrad has provided for critical errors by using the ErrCode% variable as a flag for just this purpose. Simply handling routine, and call FileCopy again.
This is illustrated in the FILECOPY.BAS
demonstration program shown in Figure 2
above.—Ethan Winer

Calculating which Pascal procedures are called at runtime

able as a flag for just this purpose. Simply set ErrCode% to -1 within your error-functions or procedures passed as parame-

ters. If you want your program to be able to calculate which function or procedure to call, you usually need a CASE statement. This can, in some situations, cause significant overhead.

However, TP3 does allow direct memory accessing of the code segment. The accompanying program (Figure 3) illustrates a method to decide at runtime which procedure to call, without the big CASE state-

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LANGUAGES

The method works as follows: If we look at the compilers' output at assembly level, we find that TP3 starts every procedure with the following statements (shown disassembled):

```
PROCEDURE FOO
          POSE BP
en so
         MOV BP, 57
E9 80 80 JMP ; to the next statement
```

Now, the address that I have labeled as address zero is the offset of the procedure (Ofs(Foo)). The memory location that holds the offset for the jump is ofs(Foo) + 5. The offset is normally always zero, so execution just jumps to the next instruction. If we write some other value to that place, execution jumps to that place instead.

The value to use is the difference be- Finland

tween the location of the next instruction and the location of the desired destination. In the above there is no difference, so the value is zero. Suppose we want to execute procedure Bar when Foo is called. Then the jump should use ofs(bar) - ofs(Foo).

In the accompanying example (Figure 3) the main program calls four procedures in a loop. Procedure DoCall calls one of the four procedures using the method described. DoCall writes the offset value in procedure Dummy and then calls Dummy. The jump instruction in the beginning of Dummy transfers execution to the beginning of the desired procedure body. (If we want to change the calling order of the procedures, we need only shuffle values in the array of offsets.)-Juha Kuusama; Espoo,

Note that the dummy procedure and all the selected procedures must have arguments of exactly the same size and number. Just for variety, I changed the argument of the third procedure to an array of 2 bytes instead of an integer. The high byte is a 1, the low 44, and 1*256 + 44 = 300. which is the integer value we passed to the procedure.-Neil J. Rubenking

Converting real numbers from 6 to 8 bytes in Turbo Pascal

Turbo Pascal stores real numbers in a different format than Turbo-87, which uses the IEEE standard. Because each version can only read real number files in its own format, it is impossible to read Turbo data files directly with Turbo-87 or vice versa.

The Turbo manual's solution is to write a Turbo program to read files with Turbo Reals and write them to an ASCII file. Then, write a Turbo-87 program to read the ASCII file and write the numbers in Turbo-87 format. Two additional programs would be needed to perform the reverse conversions.

The solution I chose uses BlockRead to read either type of file. I wrote two procedures, RFrom6 and RFrom8 (real from 6 and real from 8), to convert numbers from one format to the other. The program shown in Figure 4 then uses BlockWrite to write the file in the new format.

The conversion is based on the following formats for real numbers:

For Turbo (starting with Most Significant Bit): sign

```
bits 46-8:
                     mantissa
  bits 7-0:
                     exponent
  For Turbo-87 (starting with Most Sig-
nificant Bit):
```

```
bit 63:
                  sign
bits 62-52:
                  exponent
bits 51-0:
                  mantissa
```

bit 47:

All mantissas are normalized (i.e., converted to binary scientific notation, e.g., 1.0010101 E 101). Because the first digit of the normalized mantissa is always 1, neither Turbo nor Turbo-87 stores it. Both formats store the sign bit in bit 7 of the most significant byte. Both formats store

```
PROGRAM ProcParmDemo:
  BArray = ARRAY[0..1] OF Byte;
VAR
  Offsets : ARRAY(1..4) OF Integer:
  N : Integer;
  PROCEDURE first(X : Integer);
  BEGIN WriteLn(X, ' The first!'); END;
  PROCEDURE second(X : Integer);
  BEGIN WriteLn(X, ' The second('); END;
  PROCEDURE third(B : Barray);
  BEGIN WriteLn(B[1]:3, B[8]:3, ' The third('): END:
  PROCEDURE fourth(X : Integer);
  BEGIN WriteLn(X, ' The fourth!'); END;
  PROCEDURE dummy(X : Integer);
{ Procedure DoCall modifies the machine level code
    of this procedure. }
  BEGIN
  END;
  PROCEDURE Init:
                                 { Initialize the Offset array }
  BEGIN
    Offsets(1) := Ofs(first) - Ofs(dummy):
    Offsets[2] := Ofs(second) - Ofs(dummy);
    offsets[3] := ofs(third) - ofs(dummy);
offsets[4] := ofs(fourth) - ofs(dummy);
  PROCEDURE docall(I : Integer);
    { Transfer control to subroutine number I }
    HemW[CSeg:Ofs(Dummy)+5] := Offsets[I];
    dummy(I*188);
  END:
BEGIN
                                 ( main )
  Init:
  FOR N := 1 TO 4 DO docall(N);
END.
```

Figure 3: A version of procedure parameters for Turbo Pascal, Version 3.0.

LANGUAGES

```
on (bufferings) mem 8));
(Descriptions conversion of Turbo and Turbo-47 real must
or vice warms using firmed and firmed)
9885 (47)
                                                                                                                                                                                                                                 FOR 1 := 4 DOMETO 1 DO
                                                                                                                                                                                                                                      befferout[i] := Lo((befferin[i+1] sst 3) on (befferin[1] ssx 6));
wesk CET;

(* DOTE: Delete the line above for one in Turbo Pescal 2.8. The

program works on is in TF4. *)

TER
    huffs = ARRAY[8..8] OF Syte;
buffs = ARRAY[8..7] OF Syte;
str88 = STRING[88];
                                                                                                                                                                                                                                      6 : Ind? :- Peles:
0 : fed? :- True:
10 : Spois
                                                                                                                                                                                                                                                                                           cannot use this procedure with TURBOSCO');
                                                                                                                                                                                                                                               erminn;
ng:CONVENTE creates files with 8 byte real numbers from files with');
ng-6 byte real numbers, or vice verse.');
             OCCUPAT of contribution is bufff; was bufferout a bufff;
         1, es : Integer
                                                                                                                                                                                                                                     Hedry THEM Writelm("You are running TUMBO-87,COM")
HE Writele("You are running plais TUMBO-COM"))
         FillCher(bufferout, 8, 8);
                                                                                                                                                                                                                                 EFERT Reite("Does the source file here 6 or 8 byte real numbers? ')) ReadLa(sourcelength); S(4, 8); S(4, 8); S(5, 8); S(6, 8
         (if number-5 thun exit)
IF buffer(e(8) - 8 THEN Exit;
         (charge to $607 offset (-129-1523) and reposition for $607) on := (bifferin(8)-894) SNL 4: (move the sign bit end hi part of exponent) bufferon(7) [ = Lo((bifferin(9) AMD 128) ON SI(ext));
                                                                                                                                                                                                                            Write: Source file name? '); Needingsourcename);
Write: Destination file name? '); Needingdestname
         (move the lo part of exponent and part of mantiage] buffacout(6) in In(Lecen) ON (buffacout(6) STR 3 AND 18));
                                                                                                                                                                                                                              Trite("Display all real numbers on screen (9/8)? ");
Seatin(pcist);
pcit := UpCase(pcist);
         FOR 1 := 5 DOMNTO 2 DO

bufferout[1] := Le((bufferis[1) SML 0) on (bufferis[1-1] SMR 3 );
                                                                                                                                                                                                                                   mign(fi, sourcesame); Reset(fi, sourcelength
miserfo, destiname); Rewrite(fo, destinanth);
        beffereut(1) := Le((buffer(s)(1) SML 5) (or 8) );
                                                                                                                                                                                                                                          AT
Sourcelength = 6 THES
BESIS
           oczowa rfrom@cbufferio : buff#: Vax bufferout : buff#::
         i, es : (cteper;
                                                                                                                                                                                                                                             FOR 1 := 1 TO Actualmed SO rfrom5(buffer6(1), buffer8(1));
Slockwrite(fe, buffer6, Actualmed);
        FillCharchufferout, 6, 81:
        es := ((bufferis[7] AND 127) SNL 4) OR (bufferin[4] SNS 4);
(if exponent is 6, number is 6)
If se = 8 THUN Heil)
                                                                                                                                                                                                                                             Slockbass(fi, buffars, 1888, ActualResd);
FOR 1 := 1 TO ActualResd bo rfroms(buffars(i), buffars(i));
Slockbrine(s. buffars, ActualResd);
         (change to turbs offset [-1823+129], deel with out of range numbers)
              Honge to turbs err.

x := ex-094;

y ex < 1 yers reit;

y ex >= 255 yers
                                                                                                                                                                                                                                          print - 'T' 7888
ros [ -- 1 TO Actual Seed DO
                                                                                                                                                                                                                                                    HITE

(F ISST THIN Hove(buffer8(1), r, 0)

BLAS Hove(buffer8(1), r, 6);

Write(n(r))
                        t= 1e37;
                  r :=
Enit;
                                                                                                                                                                                                                              END;
UNTIL ActualSeed = 0;
Close(fi);
Close(fe)
        #SD:
bufferout(#) := Lo(ex):
                  we the sign hit and part of mentions;
ferout(8) := Le((bufferin(?) AND 128) OF (bufferin(6) AND 15 SML 3)
```

Figure 4: A program that demonstrates converting from 6-byte to 8-byte Reals and vice versa.

```
(* NOTE: Comment out the line above and UN-comment out the line
   below for use in TURBO 3.8. The program works as is in TURBO 4.8 *)
(* ($R+,C-) *)
PROGRAM Make Reel Date;
VAR
  R : reel:
  F : file of Reel:
BEGIN
  (* The following lins is for plein TURBO 3.8 end 4.8 *)
  (* The following line is for TURBO-87 *);
(* The following line is for TURBO-87 *);
(*R := 1.234567891234567E-58; essign(F, '%DATA');*)
  Rewrite(F);
  REPEAT
    R := -18.8*R;
  UNTIL Abs(R) > 1E37: (* plein TURBO 3.8 and 4.8 *)
  (*UNTIL Abs(R) > 1E58;*) (* TURBO-87 *)
  Close(F);
END.
```

Figure 5: A program to make sample data files for the conversion program.

only positive exponents: Turbo adds an offset of 129 to the binary exponent, while Turbo-87 uses an offset of 1023.

The two conversion procedures use Shr and Shi to move the mantissts bits from one format to the other. Naturally, you lose some precision in going from Turbo 870 in Turbo 67mat. Processing an exponent involves (1) converting it to an integer, (2) displaying its offset, and (3) moving its to the new format. Because of the different ranges of numbers allowed, the Rfromf procedure converts large numbers to +1 EF3 most annual numbers to +1 EF3 most annual

You can use these procedures in many other ways, most notably to write programs that can use either Turbo or Turbo-87 files.—Robert Simons; Berkeley, Cali-

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I added a "tersion detector" to Mr. 5: mont's program—it's eary, since eshnent's program—it's eary, since eshversion has a different size for its real number type. With the detector added, the program can not only read files from either version, it can run under either version as well. Figure 5 is a short program to create
data files so that you can try out the conversion program. Note that in two places,
there are pairs of lines, one for Turbo and
one for Turbo 477. Jast comment out the
order to with the size of the program of th

Brightening backgrounds on an XT with CGA

Regarding the Test. High. Intensity. Background program (Languages, December 22, 1987), I could not get the program to function on an XT with CGA. The serven would simply go blank until I ran another program. I reviewed port 0318h in the Technical Reference manual and it states, "This is a 6-bit output-only register (cannot be read," In view of this, I think the places in procedure SetBlinkBit that attempt to read that pot are wrong.

I was able to get the program to function properly by changing procedure Set BlinkBit as follows:

If Indicator = On THEN Port[Control]:=\$09 ELSE Port[Control]:=\$29; —Kenneth Beaudrie; Denver, Colorado

That's perfectly true. By sheer accident, the program as shown works on my own system and (I assume) that of the author. But you cannot read the CRT Control port, and the program as shown previously was incorrect.—Neil J. Rubenking

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PC TUTOR



Upgrading your machine to allow multitasking options; testing a batch file for missing parameters; a full explanation of the assembler RET instruction.

Differences between the four forms of the assembler RET instruction

Can you explain the use of the assembler RET instruction when used with an operand? For example, does RET 6 mean to remove 6 bytes or 6 words from the stack? If it can be either, how can one tell? Also, explain how the FAR and NEAR procedures affect the RET instruction with and without an operand. Finally, can the operand ever be odd?-David Thompson; Olivehurst. California

The assembly language instructions CALL and RET (return) are complementary parts of the same operation. Used together, they simplify access to subroutine procedures much like their high-level language counterparts. The CALL/RET pair allows the normal program flow of execution to be interrupted and restored in a controlled manner. Although conceptually very simple, the explanation of CALL and RET requires some background.

Inside the 8088 chip, the register pair CS:IP points to the address of the next instruction a program will execute. The CS (Code Segment) register points to the start of a 64K block of memory. The IP (Instruction Pointer) register contains the offset (in bytes) of the instruction from the start of that 64K block. This type of addressing is known as segment:offset and is required because of the segmented memory architecture of the 80xx family of CPUs.

are within 64K bytes of one another and are described by the same segment (with different offsets), they are termed NEAR relative to each other. Two addresses that are more than 64K bytes apart or that use different segments are termed FAR. A NEAR CALL transfers control to a new offset relative to the current segment-changing the IP register, but not the CS register. A FAR CALL changes both. The RET instruction, the complement to the CALL instruction, also has a NEAR and FAR form.

The segment doesn't change when the CALL instruction is used to transfer control to a NEAR address. Because of this. only the offset from the start of the segment of the instruction following the CALL need be saved. The offset, a word (2-byte) address, is saved on the stack by moving it to the memory position pointed to by the SS (Stack Segment) and SP (Stack Pointer) registers. Then, 2 bytes are subtracted from the SP register to point SS:SP to the next free stack position. When a NEAR RET is encountered, 2 bytes are added to the SP register and the word located there is loaded into the IP register. This returns control to the instruc-

tion following the CALL. The process is similar for a FAR CALL/RET except that in addition to the offset, the segment of the instruction following the CALL must be saved and restored. In this case, 2 words (4 bytes) of stack space are used to hold the segment and offset return address. The segment is placed on the stack first, followed by the If the addresses of two areas in memory offset. A FAR RET removes the far ad-

dress from the stack and reloads the CS and IP registers.

PASSING ON THE STACK DOS and most other assembly language programs generally use the CPU registers to pass parameters to and from operating system functions. This is done because of the high speed of register-to-register operations. OS/2 and most high-level languages, like C and FORTRAN, pass their parameters on the stack using the PUSH instruction. After the called procedure executes the RET, the stack is cleaned by adjusting the SP register to point to its original position. The same number of bytes PUSHed is removed by simple addition. (This is because the stack pointer grows smaller as data is added.) For example, the following code fragment might be used to call the NEAR procedure FIND_AREA that calculates a room's square footage.

MOV AX. [LENGTH] PUSH AX MOV BX, [WIDTH] BX CALL FIND AREA ADD SP.4

And the procedure might be represented as

FIND AREA PROC NEAR

FIND AREA ENDP

Remember that all data must be removed from the stack in the reverse order

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that it was added. In the preceding examnle, data is added first using the PUSH instruction twice. Then, the CALL instruction places the offset of the instruction following the CALL onto the stack and transfers control to the procedure. The RET in the routine FIND_AREA resets the IP to point to the instruction following the CALL. Finally, the 2 words (4 bytes) of data are removed by the calling procedure by adding a constant directly to the SP reg-

Each time the FIND_AREA function is called, the instructions to readjust the stack will have to be included in the calling program. Some code space can be saved if the called procedure removes its own parameters. But be warned, the following code will not work.

FIND AREA PROC NEAR

ADD SP. 4

FIND AREA ENDP

In this case, the two words being removed from the stack by the ADD instruction are the wrong two. The addition will move the SP register by the correct amount but it will discard the return address and one of the data parameters-the last 2 words placed on the stack. The RET instruction will then blithely load the value of [LENGTH] into the IP register, transferring control at random, and your program will most likely crash

In order to accomplish the desired effect, the RET instruction provides an optional form that accepts a parameter, a number to add to SP after retrieving the correct return address. The parameter is always specified in bytes, regardless of whether the RET instruction is NEAR or FAR. The FIND_AREA procedure could then be coded correctly as

FIND AREA PROC NEAR

RET 4 FIND AREA ENDP

STACK ALIGNMENT Because the stack instructions store and retrieve data exclusively in 16-bit words, the SP register

should always be even. This ensures that all access takes place on word boundaries. If the SP is odd, two memory accesses will be required to retrieve each word, and program execution will be retarded. And since it is only possible to PUSH words, the parameter in the RET statement should always be even.

For trivia buffs and programmers who write sorts and other time-critical code, the only practical difference between a NEAR and FAR RET is in the execution time. A NEAR RET executes in 16 clock cycles and a FAR RET requires 24. A NEAR RET n uses up 20 clock cycles-the same number as it takes to execute an ADD SP, n instruction after a normal RET. But a FAR RET n is specified as taking only 23 clock cycles, one less than without the parameter.

Productivity Tip

The absolute best reference for obtaining technical information on IRM hardware and software products has to be the IBM Technical Directory. Available from IBM, it lists over 100 technical publications covering topics from the IBM Mouse to the PS/2 Model 80. To request a free copy, simply call (800) IBM-PCTB.

Choosing an upgrade path to allow multitasking options

I am planning to upgrade my PC so I can do multitasking. Your April 12, 1988, PC Tutor column has me wondering about the wisdom of going the OS/2 route. Would I be better off getting an 80386-based machine and using DOS 3.3 and Microsoft Windows/386?-Dale McIntyre; Centerville, Utah

One important thing your letter left unspecified was exactly what programs you want to multitask. This determines the best course for an upgrade. For example, if you simply want to be able to simultaneously run more than one of your current DOS applications, you should probably avoid the OS/2 operating system.

OS/2 suffers from the same limitations that come with the Windows environment:

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only programs that have been specifically written to take advantage of unique properties of the environment can be multitusked. Under OS/2, current DOS applications can be run, one at a time, in what is known as the "DOS compatibility box." (Or the "penalty box," iv Det Pundits.) Since only one program can be run, you may as well stick to DOS.

If you think that you would like a fallserier praphic servinorment, menu-driven windowing, and mouse interface, then Microsoft Windows 1260 may be a good of Microsoft Windows 1260 may be a good plications have been written to take advanage of the Windows environment, it's going to be a forced fit. You'll be running that the properties of the properties of the mode and paying for it with a loos in genetrated the properties of the properties of the have more than a single DOS application loaded at a time and you'll be able to hock key between them.

If you like your current programs, be they text or graphics, and all you want to do is switch quickly from one program to another without interrupting your work, you may wish to consider VM/386. Like Windows/386, VM/386 is a "hypervisor" program. VM/386 uses the "virtual 8086" mode of the 80386 to create completely independent virtual machines. You can spawn as many machines as you have memory to support and tailor their configurations individually by specifying the amount of conventional, extended, and LIM memory allocated. Each virtual machine loads its own copy of DOS and can have separate CONFIG.SYS and AU-TOEXEC.BAT files. Pressing the Ctrl-Alt-Del keys to reboot, or crashing a machine with software, will affect only the current machine.

UPCRADING HARDWARE But great software requires great hardware. If you currently own a first-generation PC is machine with an 808 or 8086 as the Chine with an 808 or 8086 as the chine with an 808 or 8086 as the but just as definitely, you should definitely upgrade. But just as definitely, you should definely upgrade. But just as definitely, you should be even considered that is built around an 80286 chip. Limited by its early hardware design, the 80286 doesn't provide acknowledge support for a good multitasking operating system.

Traditionally, most 80286-based machines have been used solely as fast PCs, and will be limited in the future to running only the 16-bit versions of 0592. The 80386 microprocessor, however, is a whole new ball game. An improved chip design, higher clock speeds, and the abiliity to move data in 32-bit chunks combine to put the computing power of a mainframe on your desktop.

In addition to being able to run all 80286 operating systems and software, the 80386 provides two major enhancements over the 80286 a built-in memory-management and paging system and 32-bit operations and data types. Applications designed to take advantage of the 32-bit mode of the 80286 will provide a clear upgrade path and not just an incremental change.

Determining if a batch file is missing a parameter

In an MS-DOS batch file, is there any way of checking whether the value of a replaceable parameter is missing?—Howard Fairman; Mount Royal, Quebec, Canada

To determine if a replaceable parameter in a batch file is empty or missing, simply add an extra character to each side of the equality test. The following batch file demonstrates the technique.

IF %1t == t GOTO LABEL1 ECHO PARAMETER OKAY GOTO END :LABEL1

ECHO PARAMETER MISSING

Ask the PC Tutor

The PC Tutor solves practical problems and explains points of general interest about using your hardware and software more productively, and answers basic questions about DOS and systems in gen-eal. To see your questions answered here, drop a line to PC Tutor, PC Magazine, One Park Avenue, New York, NY 10016. We're sorry, but we cannot answer questions personally 2009.



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gram: more

viawed; PC Labs tests 20 MHz Deskpro; do-it-yoursalf 386s; 17 Lotus 1-2-3 add-ins; add-ins for word processors, da-tabase managamant. tabase managamant, and printing/graphics/ utilitias; sharing laser printars; Turbo Pascal 4.0; music programs; 6 naw FAX boards exam-inad; FREE Paint pro-

1/12/88-THE 8EST OF 1987—4th Annual Best & Worst Editors' Per-sonal Picks: 1987 Awards for Technical Ex-cellenca: Tandy's 1000 Serias: remota comput-ing solutions: 4 Fiber-optic LAMs: PC Labs tests 5 communications programs; 9 plug and play data transfer prod ucts: FREE Helo utility:

12/22/87-Microsoft Ex cal raviawad; PC Labs tasts 9 affordabla 386-based PCs; 16 EGA Plus cards reviawed, 8 plot-tars: 6 TSR note-takers: 5 sales-lead trackers Microsoft Windows, Om-nis Quartz; Windows Graph; adding subdirec-torias and hard disk compatibility to rejuvenate old programs: FREE PRN2FILE.COM program printing utility.







11/24/87—Apple's Mac intosh II system exam-ined; natworking ISM ined; natworking 18M and Macintosh; optimiz-ing Turbo Pascal; Power Programming column pramiares; 386 operat-ings; systams; 5 full-page, black-on-white monitors for CAO and desktop publishing; disk caching; FREE Stick cursor stabilizar utility-



11/10/87—PC Labs tocture tasts 106 printers; 36 laser printers; \$1,795—\$18,750, 300—1200 dpj. 65 dot matrix printers; 5 daisy-whaail printars; soft-font primar; first 11/10/87-PC Labs to: soft-font primar; firs look at Microsoft Excal customizing cursors with CTYPE; Compaq Deskpro 85/20 and port abla 386; FREE SAFARI

internal arror handling



10/27/87-PC Labs tests 10 hot spread-sheats; 3-0 spreadsheets that provide missing links; naw models, new screens for laptops, 6 presentation-size monitors, 386 Turbo boards; the new Multi-Mate, text-criented data basa softwara; FRFF super clipboard utility works with any application more



10/13/87—Desktop pub-lishing on the PC; PC Labs tasts GEM Desktop Publisher, The Office Publisher, PageMaker and Ventura Publisher; the best large-screen monitors, laser printers, mice and scannars: 7 highest-spaed ATs; 32 brankthrough tast and graphics scannars, 31 spelling checkars, FREE pop-up addrass book



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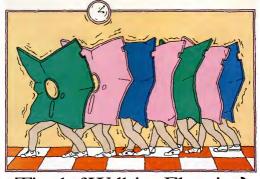
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A simple utility that captures NetBIOS hex return codes and translates them into their Englishlanguage equivalents; the best way to make wide-area links between LANs.

X.25 services are the best alternative for linking LANs over a wide area

We have four IBM Token-Ring Networks, one at a central location and three at satellite locations. We want to link them so that the PCs in the satellite networks can access a database maintained on a file server at the central location. What software and associated communications equipment do we need in order to do this?—Michael Millet: New Orleans. Louisiona

How to make wide-area links between LANs is an increasingly popular question. Since the answer depends on the LAN operating system, I'm going to assume you are using IBM's PC LAN. Novell and Banyan, for example, have different solutions.

You'll need a fast and invisible multipoint link between the LANs. The best choice is an X.25 network from one of the major carriers like Tymnet, Telenet, or Accunet. Each LAN will need a gateway into the X.25 service.

Eicon Technology Corp. has hardware and software that let one PC on your LAN become a gateway between the LAN and nx. 2.5 network. This hardware/software combination uses the NeiBIOS you already have to support PC LAN and to link the gateway with the LAN. You can call Eicon Technology Corp. at (514) 631–2592.

You'll need one set of Eicon Access/ X.25 hardware (\$1,695) and Attach/X.25 software (\$400) for each LAN. You'll also need a dedicated leased telephone line from the central-site LAN to the nearest Tymnet or Telenet entry point. The cost of this line is set by local telephone tariffs. Depending on the traffic, you may need leased lines from each satellite location to their nearest entry points, or you may be able to use slower, dial-up X.25 services for the satellites.

The cost for using Tymnet or Telenet is based on the volume of data and other factors. You should figure roughly a dime per thousand characters.

You would be smart to call your local Tymnet, Telenet, and Accunet (AT&T) representatives for bids. They can provide just the network service or do the whole job for you, for a price.

NetBIOS Reporting Utility: Part 2 Tap into the talk between applications and NetBIOS

In the last issue, we published a utility called RNETBIOS that monitors and displays the commands contained in the network control block that are sent from the application program to the NetBIOS service module. RNETBIOS contains the English-lan-

guage definitions for 36 functions requested by application programs. As application programs make these calls, RNETBIOS lists them on the screen. The requests scroll down the screen so that you see a running description of what the application has done.

RNETBIOS also watches for messages

and requests coming from NetBIOS modules in other PCs and reports what type of commands they contain.

This RNETBIOS program is useful for people developing NetBIOS applications. It lets you see if your code is working without taking a lot of space in RAM.

ENETBIOS is the left-handed twin of RNETBIOS. ENETBIOS captures hexadecimal return codes sent from the Net-BIOS module to the application. The great majority of these return codes signal error conditions, but a few, like Command Still Pending, are used in almost every transaction to indicate that the module is alive.

The ENETBIOS program is useful as a debugging tool. It lets you see the results of the NetBIOS module's activity in your LAN operating system as well as certain network adapter card functions.

The easiest way to obtain ENETBIOS .COM is to download it from PC MagNet. Instructions for using this service are given in each issue's Utilities column in the "By Modern" sidebar. The source code for ENETBIOS.ASM, which you can use to automatically create ENETBIOS.COM, is listed in Figure 1.

The code for ENETBIOS is similar to the code for RNETBIOS in that they are both TSR programs that occupy about 1,100 bytes. ENETBIOS, however, looks at a different byte in the network control block and contains the English equivalents of these hex return codes.

The program contains English mes-

sages for 30 of the 256 return codes. Some of the categories of return codes are grouped together into generalized mes-

■ CONNECTIVITY CLINIC

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Figure 1: The source code for ENETBIOS ASM, a program that monitors and displays return codes sent from NetBIOS to the application.



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CABLES409	PLOTTERS
COMMUNICATIONS . 409, 410	POWER PROTECTION
COMPUTER	PROTECTION
SYSTEMS 410, 411	POWER SUPPLIES 41
DISK DRIVES 411, 412	PRINTERS41
DISKETTES 412, 413	SECURITY41
EXPANSION UNITS413, 414	SPEED DEVICES
MONITORS	

SOFTWARE	
ACCOUNTING 415, 416	MAILING PROGRAMS 422, 423
ARTIFICIAL INTELLIGENCE	MANUFACTURING 422, 423
BACKUP SYSTEMS	MEDICAL42
BUSINESS 416, 417	MUI.TI-USER
	SYSTEMS
BUSINESS PROJECT MANAGEMENT 417	MUSIC423, 424, 43
BUSINESS TIME MANAGEMENT417	ONE-OF-A-KIND
	OPERATION SYSTEMS
COMMUNICATIONS417	PREVENTATIVE MAINTENANCE 424, 42
CONSTRUCTION 417	PROGRAMMERS
DATA BASE 417, 418	PROGRAMMERS TOOLS425, 42
DATA ENTRY418	PUBLIC DOMAIN 426, 42
DATA	REAL ESTATE42
MANAGEMENT 418	RELIGION 427, 42
DESKTOP PUBLISHING 418, 419	SALES MARKETING42
EDUCATION419	SCIENTIFIC
ENGINEERING 419	SECURITY 428, 42
ENTERTAINMENT/	SERVICES
GAMES 419, 420	SHAREWARE
FINANCIAL 420, 421	STATISTICS 429, 43
FLOWCHARTING 421	SURVEYS43
GENERAL 421	TAXES
GRAPHICS421, 422	TERMINAL EMULATION 43
HEALTH	TRAVEL43
INVENTORY422	UTILITIES 430, 43
LANGUAGES422	WORD 43
	WORD

MISCELLANEOUS

ACCESSORIES432	DISK CONVERSION 434, 435	
BAR CODING 432, 433	DISKETTE COPY SERVICE435	
PUBLICATIONS 433, 434	EMPLOYMENT OPPORTUNITIES	
BUSINESS OPPORTUNITIES	FURNITURE	
COMPUTER INSURANCE	LEASING/RENTALS	
COMPUTER SERVICES	MAILING LISTS	
CONSULTANTS	NETWORKING 435	
DATA CONVERSION434	SUPPLIES	
DATA RECOVERY SERVICES434	TRAINING/TUTORIALS . 436	
SERVICES434	TYPESETTING 436	

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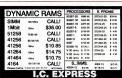
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INDEX TO ADVERTISERS

RS #	ADVERTISERS	PAGE	RS#	ADVERTISERS	PAGE	RS #	ADVERTISERS	PAGE	RS #	ADVERTISERS	PAGE
267	3M Data	281	472	Curtis Mfg.	282		Lotus Development	75	214	Samna	138
538	Addison-Wesley	324	486	Curtis Mfg.	284		Lotus Development	102-103	470	S8T	. 20
493	Advanced Logic		220	DAC Software	69	263	Macola Inc	331		Seagate	261
	Research	9	375	Data Access Corp		224	Mannesmann Tally	302	184	Shamrock	401
270	After Technology	369		Data World	159	387	MHI Warehouse	407	118	Sharn Flectronics	298
521	American Semi	040	247	Datacopy	352	50,	MICRD8EST	304	252	Sigma Designs	210
UL.	Conductor	403	504	Datastorm Tech	21		MicroCom Systems	18	123	Silicon Specialties	172,173
475	American Small Business		313	Datavue	244		MicroLogic Corp		1.0	Softline	
262	Amherst Int'l	86	392	Datran.	204		Microsoft	25.0	334	Softlagic Solutions	20
185	Aptech Inc.	207	536	Dell Computer Products	910 HIZ		Microsoft	374	307	Software Publishing	210 211
336	Arlington Computer	201	533	Dell Computer Products			Microsoft			Software Publishing	310-311
330	Products	200 200	741	Delta Computer	270		Microsoft	264.266	307	Software Security	330
230	A.S.P. Computer Produc	280-288	256	Delta Technology	270	331	Microsoft	.304-305		Sourcemate Information	
166	A.S.P. Computer Produc	15302	229		336		MICTOWAY	340	215		
	AST Research	291	229	Discount Micro		371	Mitsubishi	18-19		Systems	269
165	Autodesk			Products	142-143	373	Mutoh America		390	Spield Computer	50
204	Avery	350		Dow Jones News	269	110	Nasdec	258	161	Storage Dimensions/	
•	Bay Express	407	379	Dyna Computers	28	344	National Computer			Maxtor	267
172	Bay Technical	141	330	Dynamic Microprocesso	f		Ribbons	392	517	ST8 Systems	338
482	Bedford Software	49		Assn		394	NEC Information System	ıs 266	156	STSC	
275	Bentley Computers	382-363	534	Dynaware	347	147	Netline	384	274	Suntronics	405
116	Slaise Computing	101	511	Bite 8usiness	326		Northoate Computers	44-45	299	Swite International	37
125	Bottin Ltd.	339	170	Founta Systems	211		Northoate Computers	325	249	Symantec Corp	29
138	Borland	C2-4	352	FASTMICRD	53	285	Novel Inc.	194,196	232	Tandon	262,263
	Borland	1	286	Fifth Generation	251		Dracle	47	289	Tandy/Radio Shack	209
137	Borland	67	174	Form Worx Inc.	127	381	Para Systems Inc.	72	206	Telemart	170,171
377	Borland	55	146	Gateway Communication	vs 188	722	PCC Systems	338	123	Telemart	172,173
326	Buttalo Products	220	740	GE Computer Service	100	310	PC 8rand	32	264	The Complete PC	42
481	Buildog Computer		266	General Technology	- 60	311	PC 8rand		248	Timeworks, Inc.	100
494	SuttonWare Inc.	204	506	Generic Software	380	308	PC Brand	23	259	The Laser Connection	100
349	C. Itoh Digital Products	170	369	Golden Bow Systems	303	309	PC 8rand		393	The Software Link	970
535	Canon U.S.A.	176	502	Group L		301	PC Express	20	393	Toshiba	3/3
160	Central Point	01	380	Hammerly Computer	295	303	PC Express	26	231	Touchbase Systems	103
120	Central Point	19	351	Hard Drives Int'l	101		PU Express	39	231	Traveling Software	200
120	Central Point	rs	351	Hard Drives Int I	297	304	PC Express	31	223	Traveling Software	79
530	Chancelogic Inc	107	276	Hauppauge Computer	32	l :	PC Connection		389	Turbo Power	303
750	Chicotry American	254	201	Haventree S.W	390	372	PC Designs	373	268	Tussey Computer	. 292-294
114	Citizen America	2-3	342	Hewlett-Packard	175	353	PC Network	400	364	Ventel	14
134	Clarion Software		339	Hewlett-Packard	177	145	PC Sig	395	317	Ventura Peripherals	182-183
188	Command Technology	350	265	IDE Associates	124-125	358	Peachtree Software	87	329	Vertex Systems	200
261/5	523 Compact Disc Produc	ts 354		Informix Software	332-335	366	Persoft	64	127	Video-7 Inc.	90-91
	Compag Computer		382	Intelligent Micro		365	Persoft	58	171	Warehouse Data	
	Corn	129-138		Systems	318-319	282	Personics Corp	17		Products	82-83
279	Compu Add Corp	218-243	370	Interlock	336	489	Personal Computer Sup	nort		Watcom	114
320	CompuAdd Corp	184-187	269	International Battery	176	100	Group	10.	485	Westiake Data	271
246	Computer Direct	65.67	378	lomega	212	483	Personal Computer Sup	oort	528	Whole Earth Computers	266
109	Computer Discount	00-01	219	Irwin Magnetics	200 200	400	Group	***	508	Wordperfect Corp	200
109	Warehouse	402	243	Jade Computer	405	164	Plus Development	255 257	734	WYSE Technology	101
183	Computer Mail Drder	240 240	346	Jameco	202	209	Princeton Graphics	- Z00-Z01	337	Zenith Data	101
163	Computer Products	348-349	108			189			723	Zeos International	270
103				JDR	390		Duadram	30/	123	Zeos International	3/9
	United	210-211	169	KAD	108	749	Ricoh		721		
251	Consumer S.W. Inc	357	167	Kensington Microware.	199	479	Rightsoft	78	338	Zortech	158
253 225	Consumer S.W. Inc	355	217	Larson Systems	268	290	Rose Electronics		316	ZyLA8 Corporation	339
225	Core International	259	280	Laser Go, Inc	296	510	S-100	397			
326	Crosstalk/D.C.A	88-89	341	Lifetime Memory Produc	≭s 356	385	S.C. Systems	80	N	to Reader Service #. Plea	ise call
194	Coupar Mountain S.W.	363	182	Logitech	272-273	728	Safeware	324	adver	rtiser for information.	

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Griespie - District Menager 03-5294 2 - District Sales Representative -5307



EDITORIAL PRODUCT INDEX

148 149 AFTE 358	Boca MCA Senal		_								
149 AFTE 358 358				697	LanScanner	3Com Corp.	204	644	Hyperflex HF24	Quine Corp.	25
AFTE 358 358	Darreliet	Boca Research		698	LattisNet	SynOptics .	201	640	Internal DuraPak	Sysgen Inc.	27
AFTE 558 558				697	MultiCornect	3Com Corp	204	645	Passport	Plus Development	25
558 558	STB Senal 2	STB 5 vsterns Inc.	S1		Repeater					Corp.	
558 558	R HOURS			697	PairTamer	3Com Corp.	204	643	Plato Hardpac 20	Anstote Industries Inc.	25
358		Compact Disk Products	444	DATA	BASE MANA	GEMENT		649	SyQuest SQ555 TransPac	SyQuest Technology	27
		Inc.		440	Paradox DS/2	Borland International Inc.	43	642 650	Traveldisk 10 (Model		25
		Compact Disk Products Inc.		444 445	R:base Compiler Sycero do	Microrim Inc. PC Publishing Inc.	52 51	641			27
JQ.	For Record Collectors	HomeCraft Computer Products			TOP PUBLIS		<u> </u>	651	2)	Inc.	
356		MicroProse Simulations				IMSI		651	Verbatim 12MB Internal Subsystem	Eastman Kodak Co.	21
		IBM Corp.	440	434	PagePerfect	IMSI	56				
		Music Duest Inc.	446	MON	TORS			SCAN	INERS		
569		RolandCorp US		432	Selko CM-1430 Col Monitor	or Seiko Instruments USA	48	431	Handy Scanner HS- 2000	DFI	4
	MPILERS/INTE	DODETEDA	-1	OPTI	CAL DISK DR	IVES	_	SOFT	WARE		_
			_	442	Discus Rewntable	Advanced Graphic	52	446	Maginto	Mapinto Corp.	- 5
582		Marix Software Systems	122		Discus in minuse	Applications	~		ADSHEET ANA		
581		Systems Computer Innovations	126	435	IBM 3363 Optical	IBM Corp.	46			LYSIS	
		Oakland Group Inc.	156		Disk Drive			429	Value Pack	Lotus Development	
		Gimoel Software	166	PRIN	TERS		_			Corp.	
		FairCom					_	UTIL	TIES		_
		Magna Carta Software .	150	430	CrystalPrint WP	Qume Corp.	54	450	Hummingbird (HP*)	Cauldron	- 5
560		Solution Systems	156	REMOVABLE MASS STORAGE 648 Ad Par. Tandra Com. 266				Browser			
		Raima Corp		652	Bernoulli Box II	Tandon Corp. Iomega Corp.	266 250	WOR	D PROCESSING	a	
		C Ware		646	Datamodule	Western-Dynex Corp.	275 -	441	Sprint	Borland International	3
		Fossett Inc.		647	External DuraPak	Syspen Inc.	279	441	орин	Inc.	۰
		MetaWare Inc.	140	041	District Contract	oyogen no.					
578	High C386	MetaWare Inc	140								
		Rational Systems	166	PPAI	DUCTIVITY						_
	Lattice C	Lattice Inc.	145	DEPART		PROGRAM WANT DESCRIPT					24
		Mark Williams Co		DEPARTS	PERT	PROGRAM NAME DESCRIPT	108E				P.A
		Microsoft Corp.	149	PC Lab I	Votes.	Speed optimization techn	ocues for	Microsoft	C and Turbo Corcora	ms	2
		MicroWay Inc	157	Utilities		FONTEDIT modifies, crea					3
573		Mix Software Inc.	158	Environ	ments	Dialog Box in Presentatio	n Manao	er BOXES	orogram gives you m	any options.	3
567 572		Blaise Computing Inc Microsoft Corp	156	Power F	rogramming	TRYDSORT Cand DWK	SDRT.C	ase the Cv	ersion of the Duickson	t algorithm	3
572 555		Ane of Reason			heet Clinic	Avoiding extra page feed:	griffing	1-2-3 wo	rksheets with hidden or	olumns	3
		Borland International			heet Clinic	Creating a pause in 1-2-3				id.	3
24.0		Inc.			heet Clinic	Converting six-digit label					3
165		Creative Programming			heet Cirric	Changing the cell coordin					3
170	Watcom C	Watcom Group	400		heet Clinic	SuperCalc4 bug returns (by 0.	3
				User-to-		Using environment varial				in an	3
COMI	MUNICATIONS			User-to-		Speeding up repetitive ta				M in DUS.	3
433	Worldport 2400	Touchbase Systems Inc.	54	Power L	iser	Changing directories with Using Microsoft Word's	nested r	macros" b	enter glossary entries		- 3
	PUTERS	Mile.		Power L		Interactive dBASE comm					3
				Power L		PRINTSCR.BIN prints the					3
436	ALR FlexCache 25386	Advanced Logic Research	35	Power L	iser	STARTUP MAC displays initializing memory varial	oles in dE	ASE, Food	BASE, Clipper, and DB	XL.	3
437	Compaq Deskpro	Compaq Computer	38	Power L		Speeding up execution of					3
	386/25	Corp.		Langua		FILECOPY copies fres in					3
438		Hertz Computer Corp		Languag		Turbo Pascal PROCPARI					3
139		IBM Corp.		Langua		CONVERTR converts 6-b					- 3
	A21			Languag		Turbo Pascal Test, High,					- 3
443	Wells American	Wells American Corp.		PC Tuto		Using the assembler CAL					1
	CompuStar			PC Tuto		Whether to upgrade to Of Checking whether a para					3
CONF	NECTIVITY				r tvity Clinic	Link LANs with IBM PC L					3
	HP StarLAN 10	Hewlett-Packard Co			vity Clinic	ENETBIDS captures hex					3

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301 307 303 304 305 305 307 300 307 307	1390 311 32 313 314 315 316 317 316 1 1390 313 323 333 344 345 356 367 360 1 1410 411 412 413 414 415 316 417 417 417 417 417 417 417 417 417 417	119 300 71 127 237 31 72 73 73 74 25 74 27 37 37 31 19 49 49 37 31 37 37 37 37 37 37 37 37 37 37 37 37 37	
In which of the following sectors does your organization operate? {Check one.} Private industry b Government c Education 2. Your primary job function is (check one):	1. 🗆 11-25	6. Does your company own c Moinframe(s) s. Mint(s) t. Now u. In 4 to 6 months v. In 6 to 12 months w. No definite plans	PLEASE PRINT CLEARLY—use only one cord per person Nome. Buriers Phone (
d. MIS/DP, Communications Systems, Programming e. Engineering/880 E. Finance/Accounting	m. 26-100 n. 100 or more 5. Are any PC's in your office?	8. Number of employees in your entire company? z. 25 or less y. 26-99	City
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COMING UP

PRESENTATION GRAPHICS
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do more than counter audience indifference—skillful use of sides can lift a presentation from the merely competent to the
unity informative on entertaining, in this
graphic, we review graphics software designed for use in studies and art departments, as well as basiness offices. Ourreviewers look at 21 programs, including
Software Publishing is Hurward Graphics,
which were the studies of the side of the side

THE PRODUCTS/SERVICE COM-BINATION Some companies offer graphics power beyond what you can receive from PC software alone. Aztek, Genigraphics, Autographix, Crusfield Dicomed, and Management Graphics can provide a variety of solutions—in combinations of hardware, software, and graphics services—at a variety of price services—at a variety of price.

ATTENTION-GETTING SLIDES Your choice of colors, the shape and size of the text included in your graph, the length of the lines, and the amount of information in your chart can make for either an eye-popping slide or a cluttered image. Dona Z. Meilach, author of several books on effective business presentations, tells how to create slides that convey messages with impact.

ANIMATED PRESENTATIONS If a picture is worth a thousand words, then animation speaks volumes. Leff Einstein, a professional animator, looks at five PC animation programs that will make your presentations unforgettable—IBM's PC Storyboard Plus, Showpartner FX, VCN Concorde, PC Emcee, and Grasp.

SLIDE SERVICE BUREAUS If you need high-quality slides but your company can't purchase a film recorder for in-house use, service bureaus may be your answer. We look at the range of services available from five major service bureaus—Brilliam Image, CompuFilm, Expresslides, MAGloorp, and Visual Horizons.

Congratulations to the WINNIAS of the Ziff-Davis \$50,000,00 Computer

Here are the 44 Lucky Winners selected in a random drawing of entries in the 1987 Zif-Davis \$50,000 Combuter Sweetstakes!

Sweepstakes!

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Robert M. Carper
Howell B. Payne
Marc C. Irish

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Quadram Datavue 25
Portable Computer

Ralph Zemel
Robert H. Kershberg
Frank G. Artale
Philip A. McHale
Harold Brunink

Allan E. Pronousst fim Mikesina Donna M. Ellinger Evan Stein Carl S. Christensen

THIRD PRIZE
Epson LX-80 Dot Matrix Printer

Ronald E. Roeser Rondall Dunditis Kent Hale Byron Ranjit Solanki Ronald L. Barnett Gragory Kraigher Clayton Schmitt Robert Cheek Katherine Nance Gary F. Murajda

John Faulent Robert A. Wilson R.S. Schiller Ralph Farber Terrance W. Thompson Matrix Printer
Ardis Milano
Linda A. Bulluck
Shirley Davis Pettus
Kristina Victoreen
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Bob Deschenes
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Frank Hill
Robert Greenblatt

Advertisers product index

R\$#	AINFEITSER PROD	NET	PAGE# BS-	,11	ACIVERTISER PRO	DUCT	PAGE
	ACCOUNTING SOFTWARE				PROCESSING SOFTW		
185	Atteching	Abravae			Group L Corporation	Marrony I ann	201
482	Aprech Inc. Bedford Software Limited	Abravas Accounting Software		í	LaserGo Inc.	Go Script	296
194	Counar Mt Software				Micro Com Systems	Go Script	in SW 18
220	OAC Software	Accounting Software Accounting Software	69 479	9	Rightsoft, Inc.		
482 194 220 263 358	Macola Inc.	Accounting Software		4	Samma Software Publishing	Word IV Professional Write	136
470	Peachtree Software SBT Corp	Accounting Software Database Accounting	20 508		Wordperfect Corporation	Wordpertect 5.0	300-31
215	Sourcemate Information Systems	Accountmate	269 316	8	Zylab Corporation	ZY Index	330
	K TOP ORGANIZERS	7000070700		AD/C		21 1194-111111111111111111111111111111111	
PES	Micro Logic Corp.	Tornado			American Small Business Como	Design Cad Software	361
-		10/1900	165	5	Autodesk	Autosketch	99
	ABASE MANAGERS		506		Generic Software Inc.	Genenc Cadd	30
494 375	Buttonware Data Access Corporation	PC File	206 SF	PRE.	ADSHEET/TEMPLATES		
310	Oracle	Database Management S	oftware 47 255	3	CSI	Spreadsheet Toolbox	355
			485		Microsoft	Word 4.0	
	SYSTEMS & ACCESS M				Personal Computer Support	Lucid	11+14
185 502	Aptech Inc.	Abravas Memory Lane			OLL/PERSONEL		
902	Group L Corporation Micro Corn Systems	Multifunction Public Don	noin SW 16 185	5	Aptech Inc.	Abraxas	200
		metrolicom reon, con	DI	ESK	TOP PUBLISHING		
INF	DRMATION MANAGERS		636	5	Canon USA Inc.	Desidop Publishing	8
	Lotus	Agenda Multifunction Public Don	102-103 280		LaserGo Inc.	Go Script	29
	Micro Com Systems Micro Logic Corp.	Torredo	nam SW 16 295	9	Swite International, Ltd	Glyphix	3
365	Persoft	Tornado	are58 D/	ATA	ENTRY SOFTWARE		
INT	GRATED SOFTWARE		174	4	Form Work Inc.	Form Worx	12
	Informix Software Inc.	Smartware	200 20E VI	ERT	ICAL MARKET SOFTW	ARE	
	Lotus	Symphony			Compact Disc Products	Compact Disc-CD ROM	26
156	STSC	Statgraphics				Outped Disc of Hom	
TAN	GUAGES				ATIBLE KEYBOARDS		
		DBase III	72	_	Zeos International	Keyboards	37
538 116	Addison Wesley Pub. Co. Blaise Computing	Programming Tools		ACK	UP SOFTWARE		
138	Borland International	Turbo C		5	Core International	Corefast 2.0	29
	Borland International	Turbo C		5	Westlake Data Corp	Backup Software	27
380	Hammerly Computer Services, Inc. LaserGo Inc.	Pro Bas, Pro Bas Tool Ki	I 181 DI	ISK	BACKUP & TAPE DRIV	E\$	
200	Microsoft	Co Script	164.166 286	6	Fifth Generation	Fastback Plus	25
	Microsoft	Word 4.0			Iomega Corporation	Removable Mass Storage Tape Back-Up	21
	Microsoft				Irwin Magnetics	Tape Back-Up	388-38
331 389	Microway Turbo Power Software	Fortran Compiler Turbo Pro 4.0/Turbo Ars	340 H	ARD	DISKS		
303	Watcom	Watcom C		2	Datran	Hard Card	30
338	Zortech	C++		1	Hard Drives International	Hard Disks	29
PRO	GRAM DEVELOPERS/GE	NEDATORS	341	1	Lifetime Memory Products Plus Development	Hard Disk Drives Passport	
	Chancelogic Inc.	C-Code Generator	107		Seagate	Hard Disks Large Capacity Hard Disc Personal Data Pac	26
530	Clarion Software	Ciaron	70 161	1	Storage Dimensions/Maxtor	Large Capacity Hard Disc	Orives 25
380	Hammerly Computer Services, Inc.	Cianon Pro Bas, Pro Screen	161 233		Tandon Corp.	Personal Data Pac	262-26
PRO	JECT MANAGEMENT				PUTERS/COMPATIBLE	S	
249	Symantec Corp.	Timeline	29 493	3	Advanced Logic Research After Technology Corp.	Computers PC Compatibles Compatibles Compatible Compatible Compatible Compatible	
===	TISTICAL SOFTWARE		275	Ĕ	Meditey Computers	Comostblee	362.36
				ĭ	Building Computer Products	Computer/Accessories	60-6
156	STSC	Statgraphics			Compag Computer Corporation	Compatible	129-13
TEX	T EDITORS		321	0	Compu Add	Compatibles	184-18
188	Command Technology Corp	SPF/PC	350 27	9	Compu Add Computer Products United	Compatibles PC's	276 27
100	LITIES	•••••			Dataworld	PC's	15
		20000	536	6533	Dell Computer Products	PC's Desktop Computers Detta Gold	110-11
137	Borland International Central Point Software	Sidekick Plus PC Tools Deluxe		1	Delta Computer Corporation	Delta Gold	27
120	Central Point Software	Copy II PC Deluxe Option	1 Board 75 74	a	Dyna Computers GE Computer Service	386 PC	
160 120 134 253 392 256	Clarion Software			2	GE Computer Service Intelligent Microsystems	Compatibles	318-31
253	CSI				Northquie Computer Systems	386 Machine Compatibles	44-4
392	Datran	Hard Card Direct NET/Direct Access	304 377	2	PC Designs Spield Computer Systems	Compatibles	37
100	Delta Technology Golden Bow Systems	V-Opt		0	Spield Computer Systems Tangy/Radio Shack	PC's	5
369 502	Group I Cornoration	Memory Lane		9	Vertex Sustance	Compatible	20
380	Hammerly Computer Services, Inc.	Pro Bas Pro Screen		Ä	Vertex Systems WYSE Technology	PC Modular Systems Archite Competible	chure 18
280	LaserGo Inc.	Go Script		1_	Zeos International	Compatible	150-15
:	Micro Com Systems Micro Logic Corp.	Multifunction Public Dor Tornado	nam oW16	IPU'	TDEVICES		
110	Nasdec	Utilities		0	Chicagy American	Keyboards	
489	Personal Computer Support	Breakthru	10 37	o	Inter Lock, Inc.	Input Devices	33
282	Personics Corp				Microsoft	Mouse	354-36
489 282 290 334 248 223	Rose Electronics Softlogic Solutions	Passport	354 *		Northgate Computer Systems	Keyboard	32
	Soundar Sounds	Disk Optimizer	39	1111 7	IFUNCTION BOARDS		
248	Time Works Inc.						

R\$#	ADVERTISER PRO	DUCT PAG	# RS#	ADVERTISER	PRODUCT	PAGEA
	-ON BOARDS		MOI	DEMS		
166	AST Research	Rampage	31 364	Ven-Tel	Modems	14
120	Central Point Software The Associates	Copy II PC Deluxe Option Board	EML	JLATORS/PROTO	COL CONVERTORS	
265 127	Video 7	Add On Boards. 90-	366	Persoit	Term Emulator Software	
SCA	NNERS/DIGITIZERS		DISI	KETTES		
247	Outa Copy	Scanner	52 262	3M Oats Recording Produ	cts Oiv 3M Preformatted Oisketh	251
182	Logitech	Scanman 272-2	73 169	KAO Corporation	Oiskettes	168
	ITERS		INS	URANCE		
172	Bay Technical Associates	Print Master II		Saleware	Insurance	324
328	Buffalo Products C. Itoh Digital Products	SL Penpheral Sharing Device	MAI	NTENANCE		
114	Citizen America Printer			NEC Information Systems	NEC Information System	266
251 142	CSO Hewlett Packard	Out	7 PON	VER PROTECTION		
339	Hewlett Packard	Laserjet 1	7 167	Kensington Microware Ltd		100
280	LaserGo Inc. Mannesman Tally	Go Script 2 Laser Printers 3	381	Para Systems, Inc.	Minuteman	
749	Ricoh of America	Laser Printers 3		URITY		
349 114 251 342 339 280 224 749 259	The Laser Connection	OMS-PS R10	5	Software Security	Software Protection	6
	Ventura Peripherals	Dot Matrix Printer		ACCESSORIES		
	TER RIBBONS			Amherst International	PC Accessories	
344	National Computer Ribbons	Computer Ribbons 3	204	Avery	PC Accessories	
	ITER ACCESSORIES		472	Curtis Manufacturing	PC Accessories	282
290 290	Rose Electronics Rose Electronics	Masterswitch		International Battery Corp	Batteries	170
	TABLE/LAP COMPUTER		me	LORDER		
313	Datave	Spark 5	521 44 335	American Semiconductor Arlington Computer Produ	Mail Order	200.200
217	Larson Systems	Mitsubishi Laptops	W 330	Bay Express	Mail Order	407
371	Mitsubishi Electronics	Laptops		Bertley Computers Boffin Limited		
	Toshiba	Computers Laptop	33 125 481 320	Bull Don Computer Produc	Mail Urder	60.61
PC F			320	Bull Dog Computer Produc Compu Add	Mail Order cts Computer/Accessories Mail Order	184-187
189	Quadram Corp.	JT Fax 3	37 279 246	Compu Add Computer Orrect.	Mail Order	218-240
	LAYS MONITORS TER		109	Computer Discount Wareh	house Mail Order Mail Order Mail Order	400
511 209	Elite Business Applications Princeton Graphics	Monitor 3 Max 15 Monitor 2	26 183 33 229	Computer Mail Order Oscount Micro Products	Mail Order	348-349
118	Sharn Professional Products	QA 25		FASTMICRO	Mail Order	142-143
337	Zenith Data Systems	Desk Tops1	33 266	General Technology Corp		
	PHICS SOFTWARE		351	Hard Drives International Intelligent Microsystems	Mail Order	318-319
534 174	Dynaware	Dyna Perspective	17 243	Jade Computer Products	Mail Order	406
300	Form Work Inc. Harmerty Computer Services, Inc. Haventree Software	Form Work 1 Pro Bas. Pro Bas Telecom Tool 1	27 346 51 108	Jameco Electronics JOR Micro Devices	Mail Order	390
201	Haventree Software	Flow Charts		MHI Warehouse		
156	Software Publishing STSC	Graphics Software	56 344	MICROBEST National Computer Ribbon	Mail Order	394
	TTERS/CHARTING DEV	ICES	31031	11 PC Brand 19 PC Brand	Mail Order Mail Order TS Computer Ribbons Mail Order Mail Order Mail Order Mail Order Mail Order Mail Order	22-2
373	Mutch America Inc.	Plotters/Charting Devices		19 PC Brand	Mail Order	24-25
	EO GRAPHICS/BOARDS	1 Diam's Grant of Devices	301	PC Express PC Cornection	Mail Order	246-24
252	Sigma Designs	VGA/H	10 353	PC Network (Formerty IM)		
517	STB Systems	VGA Add In Board	145 38 510	PC Sig S-100	Shareware	390
ACC	ELERATOR BOARDS		385	S.C. Systems	Mail Order	80
276	Hauppauge	386 Motherboard	184	Sharmock	Mail Order	40
489	Personal Computer Support	Breakthru		Silicon Specialties Sottine		
	MUNICATIONS SOFTW		274	Suntrories	Mail Order Mail Order	405
326	Crosstalk/DCA Data Storm Technologies Inc	Remote 2	89 206 11 123	Telemart Telemart	Mad Order	172-17
504	Data Storm Technologies Inc Dow Jones News/Retrieval	Communications Software	268	Tussey Computer Product	Mail Orderts Mail Order	292-294
330 170	Dynamic Microprocessor Assoc.			Warehouse Data Products Whole Earth Computer	Mail Order	
1/U 380	Equinox Systems Inc. Hammerly Computer Services, Inc.	Swetch Lan Pro Bas Telecorn Took Kit	One			
380 722 290 231 223	PCC Systems Rose Electronics	CC: Mail	36	NEC Information Systems		. 20
290 231	Rose Electronics Transhipses Systems	Passport				» 200
223	Touchbase Systems Traveling Software	Desk Link		ECT MARKETING	CONNECTION	100
	AL AREA NETWORKING		521 336	American Semiconductor Arlington Computer Produ	Mail Order	398-396
	A.S.P. Computer Products Buffalo Products	Simoleo	62 *	Bay Express	Mail Order	
328	Buffaio Products Equinox Systems Inc.	St. Perigheral Sharing Device		Computer Discount Warel Jade Computer Products	house Mail Order	
146	Equinox Systems Inc. Gateway Communications	Switch Lan	BB 346	James Electronics		
230 328 170 146 147 285 722	Netine	Many Link	84 108	JDR Micro Devices	Mail Order	39
285 722	Novell Inc. PCC Systems	Local Area Network	95 387	MHI Warehouse MICRDBEST		
	Rose Electronics	CC: Mail Masterpwitch	54 344	National Computer Ribbon	rec Mail Order	38
393	The Software Link Inc.	Lanink 5X	79 353 79 145	PC Network PC Sig	Mail order	39
223	Traveling Software	Desk Link	510	S-100	Mai Order	39
	RO-MAINFRAME LINKS		184	Shamrock	Mail Order	40
146	Gateway Communications	LAN	88 274	Suntronics	Mail Order	

AFTER HOURS



CD-ROM and Roll: Getting Audio from Your Data Drive

BY PHILIP F. H. ROSE How do you justify laying out

\$1,000 for a CD-ROM player when so little software is yet available for it? Compact Disk Products, a mail-order CD-ROM and WORM drive retailer, can help you rationalize the expense with two programs that turn your plain-vanilla CD-ROM drive into an audio compact disk player.

CD-Play and CD-AudioFile Let you play addio CDs on some Hitachi-based CD-ROM drives (such as the Hitachi CDR-1903S and the Amdick Laserdrive), which contain digital-toanalog conversion chips. Other, non-Hitachi-based drives that contain these chips may be supported in the future. (You cannot play audio CDs on drives that do not incroporate these

chips.)

CD-AudioFile loses some points because, unlike CD-Play, it is not RAM resident. This means you can't use your computer for anything else while playing CDs.

search by disk title or artist name

When you load an audio CD

into your CD-ROM player, CD-AudioFile lets you enter information about the disk into its database. The database entry screen consists of fields for disk name, artist, track names, playing times, comments, and a sequence list. Track times are filled in by the program when it first scans the disk; you don't have to enter any other information to play the CD. Any information you do enter is saved in the database in dBASE .DBF format, allowing export to many database and spreadsheet

packages.

Each subsequent time you load the audio CD, CD-Audio-File will recognize it and present you with all information

about it in the database.

The songs entered in the database sequence list can be arranged in any order, and you can repeat tracks. You can search the database for song titles, but not for artists or disk titles, but not for artists or disk titles.

CD-Play can be run in either RAM-resident or standalone mode. It scans the CD after you load it into the drive. You can then play a sequential range of tracks. You cannot specify a nonsequential list or repeat a track. No information about the disk, such as artist or song title, is saved in the program when

While the CD is running, you can use the software to re-

you remove the CD.

wind or fast-forward through it. You can also display a screen containing the track number and elapsed track and disk times.

tapped track and disk times.

These programs are similar to the desk accessory supplied with Apple's new AppleCD SC CD-ROM drive, but I am not aware of anyone else providing this ability for the IBM environment.

That uniqueness is just what makes these programs shine. While there are some drawbacks, either of these two programs could make the decision to buy a CD-ROM drive that much easier.

much easier.
List Price: CD-Ploy, \$95; CDAudioFile, \$195. Requires: IBM or
compatible, CD-Play supports
EMS if available, Compact Disk

compatible. CD-Play supports EMS if available. Compact Disk Products Inc., 217 E. 85th St., #216, New York, NY 10028; (212) 996-6999.

CIRCLE 658 ON READER SERVICE CARD

For Record Collectors: How to Keep Track of Your Stacks of Wax

BYPAUL. V. OLOWACZ

Every serious record collector
must eventually face one burning question. No, it's not "Do!
Bell my fumiture to make room
for my 45s?"—a true mave
doesn't think twice about that.
But as your archive grows, you
will find yourself asking how
you'll ever keep track of all your

The answer may be to get a copy of For Record Collectors, a \$59.95 database system from HomeCraft Computer Products. (Registered owners of other HomeCraft products can buy FRC for \$25, and a shareware version is also available.)

The program catalogs every recording you own, whether on singles, LPs, tapes, or CDs. It creates an entry for each song (up to 10 million in a file) with up to three levels of detail: facts for the Collector (title, artist, and year), the Advanced Collector (which adds writer, producer, chart position, and label), and the Radio Professional (which adds timing and play-

The manual provides only basic information for handling your data. This isn't a problem, though, as the program is menu driven and easy to follow.

For Record Collectors can search for recordings by any of 21 search fields. For example, you can quickly track down all Top 40 doo-wop ballads from 1958 with the word "Love" in the title using the Highest Chart Position, Type, Year, and Title search fields.

You can print out the results of your searches on 3- by 5-inch index cards, if you choose. FRC can also print its reports to disk files in ASCII format.

Be aware that the setup of field names is rather rigid—only a few can be changed, and none can be added.

I have a couple of gripes about FRC. For one thing, although you assign your own catalog number to each entry, you can use these numbers only for searches, not for calling uperties to edit. I also found that you can't always fit a length vit lei into the 40-character field, and the comments fields don't leave room for anything much more profound than "good beat."

But if you don't feel like

learning dBASE, and you're waist-deep in vinyl, and your head is spinning at 78 rpm, For Record Collectors is a good way to put you back in the groove.
List Price For Record Collectors, \$59.95 (\$25 for registered)

HomeCraft users); shareware version, \$7. Requires; 256K RAM, one disk drive (hard disk recommended), DOS 2.0 or later. Not copy protected. HomeCraft Computer Products, P.O. Box 974, Tualatin, OR 97062; (503) 692-

CIRCLE 657 ON READER SERVICE CARD





Gunship: Saving the World from the Red Menace

BY GREG PASTRICK

If you avoid computer-simulatd shoot-om-ups because they offend your sensibilities, you risk missing the sophisticated programming and graphics that are at the heart of MicroProse Simulations' Ganship. This fast-paced, firepower-packed program puts you at the controls of an AH-64A Apache helicopter, whose simulated flight action surpasses even the original Flight Simulator and Jet.

The action can take place in any of four international hot spots. Southeast Asia, Central America, the Middle East, or Western Europe. Outside of the pyramids and deserts that mark the Middle East, the terrain in each locale is not remarkably unique, though it is a great improvement over Jet's and Flight Simulator's sectency.

. Your foes? Bad guys packing Warsaw Pact weapons. And you do face an impressive array of weaponry—from AA guns to SAMs to tanks to attack helicopters. The locale and military quality of the troops you select dictate how tough they'll be and how new their weapons are. The weapons on the Apache are equally impressive: Side-winders (for airborne targets only), a 30mm chain gun (all targets), armor-piercing missiles, and air-to-ground rockets. Weapons can be fired only after you lock on your target using the I'ADS (Target Acquisister) and the I'ADS (Target Acquisister) and the I'ADS (Target Acquisister) and the I'ADS appears both as an illuminated square in the main screen and as a magnified 3-D image of the target on the cockpit control display.

When the TADS is not activated, the display shows a flat map view of the immediate area. This can be used along with the radar (threat display) to locate enemy positions. The larger grid map can be toggled for primary and secondary target location, as well as current mission position and friendly base locations.

The play options are impressive, too. The default training missions in the U.S. let you get a feel for chopper jockeying and allow you to practice using the Apache's targeting and weapons systems. It's the one mode in which nobody gets hurt and everyone goes home.

To fly real mission assignments, you must first correctly identify one of 20 vehicles presented following the boot-screen. A correct identification takes you beyond the default to pilot selection, tour-of-duty locale, level of danger, and selec-

Before firing those ar-toground rockers, you must lock on your sarget with the TADS, which appears as an illuminated square in the main screen and as a magrified image of the target on the cockput

commol dis

plan



tion of reality mode and enemy. Once set, these parameters become the defaults, provided you don't kill yourself or end up MIA. Briefing and assignment, intelligence report, and armament screens follow before you're allowed to enter the cockpit and wind the chopper up. You always have the option to go on Sick Call, but only a winn would do that.

A joystek is highly recomreaded—it's the only way to readly fly this simulation. It also comes in handy for toggling the TADS and firing. However, you have to use the keyboard to control all engine and root functions, select weapons, jam radar, drop chaff and flares, change views (a 180-degree range of vision), toggle the

map, and enter passwords.
Flight is a thrill. To lift off
the home-base pad, you turn on
the engines, engage the rotor,
and push the power (or collective) up—using the number
keys. For added fun, try flying
in speedup mode (activated by
thiting the Equal Sign key).

The more proficient you become in speed turns, power diving, low-level flying, and hovering, the greater your chances of surviving missions. All the electronic evasive measures are there, but when you've got an M-24 Hind attack helicopter on your, umm . hind, a climbing dive or low-level dodge between mountains may be your

only hope. Take away all the gunplay and the flight action is no less exciting.

Once you've got some flight time behind you, a mission might be set up like this for maximum danger and excitement: a hazardous, volunteer (read, mostly unsurvivable) daytime mission in Western Europe to destroy enemy mobile SAM and tank units, with a secondary target to destroy enemy helicopter bases. Flight conditions are real, with variable winds, and the possibility of a crash landing is always present. Remember, you'll be going up against first-line Soviet troops with the latest equipment. Watch out for untouchable targets and surprise enemies that pop out of nowhere

Should you survive, accomplish your mission, and make it back to a safe landing at a friendly base, you'll be awarded with medals and promotions. Then you can rearm, refuel, and return to do battle with the Red Menace.

List Price: Garuship, 549, 95
dravialable in 579- and 319-inch
floopp disks). Requires: 256K
RAM, CGA or EGA (monochrome
version available for Hervatlecard). Bysisk recommended.
Copy protected. MicroProve
Simulations, 180 Lakefront Dr.,
Heart Valley, MD 2(030: 301)
771-1151.
GRILL BISS ON PEACES SERVICE CARD.

Comba por Comba

AFTER HOURS

MUSIC

Making Beautiful Music with IBM's Music Feature Card

BY JONATHAN MATZKIN
In the year since the introduction of the IBM Music Feature,
a variety of useful third-party
software has appeared for the
\$495 synthesizer card, making
it an attractive option for anyone
interested in adding music capa-

bility to a PC.

The Music Feature card installs in a full-length, 8-bit expansion slot and attackers via a cable to an external MIDI processing unit that allows MIDI-compatible devices to interface with the PC. The MIDI interface is compatible with the Ro-land MPU-401 standard. It's a bit basic, with only MIDI In, MIDI Out, and MIDI Thru company.

In addition to the MIDI interface connector, the rear of the card has stcreo output jacks for connection to an amplifier and a headphone jack for private listening. The jack accepts the stereo miniplug that comes on Walkman-style headphones—a really intelligent choice, since many people already have such headphones, and because it allows the Music Feature to be used with no additional amplification equipment.

The card uses a process called FM synthesis to generate sound. The signal output from an oscillator is modified by the output of another oscillator.

You can generate up to eight simultaneous "instruments" with the Music Feature. Since the synthesizer is multifumbral, those sounds can be distinct from one another. The number of instruments that can be played simultaneously depends on how many notes each instrument is configured to play. If each instrument is set up to play one note at a time, a total of time, a total of

eight instruments can be accessed simultaneously. Switches on the card can be set to allow the use of up to four cards in your PC. This makes it possible for as many as 32 instrumental sounds to be accessed at once within a musical

composition.

The Music Feature's sounds vary in their approximation of 'real' instruments. They are almost all sonically appealing,

Getting Started with MIDI: Everything You Need for \$219

If you already have a MIDI-compatible synthesizer and a PC, and you want to bring the two together, consider the \$199 MIDI Starter System (\$219 including MIDI cables) from Music Quest. The kit has a MIDI interface on a half-leneth. 8-bit expansion.

card. The interface has only MIDI In and MIDI Out connectors. You don't get the MIDI Thru, tape syne, and metronome connectors that corne on full-featured interfaces, but you don't need these features to get started. In fact, the simplicity of the hardware makes setup a very simple proposition, unlikely to intimidate arrone who has installed an add-in card in a PC.

Once you have installed the MID adapter and connected it to your compatible synthesizer, you load the Easy-8 sequencer program that comes with the MID Starter System. The software installs easily and has an extremely simple, single-screen interface. Easy-8 has good help screens, and the pull-down menus are easy to figure out. I was able to start sequencing within a few minutes of copying the software to my hard disk.

The sequencer lacks many features that advanced musicians require. For one thing, there is no graphic or notational display of the music that you enter into the sequencer; you have to play it back to examine what you have recorded. But, like the hardware in the Starter System, Eary's has the essentials; you can record and play back up to eight tracks, and you can adjust basic parameters such as tempo. The program supports a mouse, but the PC

keyboard works fine by itself.

The MIDI Starter System also includes sound-editing software that lets you develop and edit sounds on several of the more-popular synthesizers, including the Yamaha DX-21 and the Casio CZ.—Jonathan Markish

List Price: MIDI Starter System, \$199. Requires: 256K RAM, MIDIcomputible instrument, two MIDI cables, DOS 2.1 or later. Music Quest Inc., 1700 Alma Dr., #260, Plano, TX 75075; (214) 881-7408.

CIRCLE 650 ON READER SERVICE CARD



Stereo output jacks found on the rear of the IBM Music Feature card let you conmeet it to see amplifier or beadphone jacks. The card installs in a fall-length expanation slot and attacks via cabling to an external MIDI processing unit that lets MIDI-compatible devices interface to the PC.

timbral variety to produce compositions of considerable textural depth. There are 240 preset sounds, and you can program an additional 96 timbres with the appropriate software.

IBM has relied entirely on third-party software to drive the Music Feature card. Texture, a professional sequencer from Magnetic Music, supports the card, as does PlayRec, a less powerful but easy-to-use seouencer from Yamaha.

Music Construction Set, from Electronic Arts, exploits the card in a way that younger users and musical novices will appreciate. Notes are referred with a mouse and drugged into place on a musical staff. Sones are played and modified by pointing to tape-recorder-like controls that are represented on the simple control streen. Another screen allows you to scroll through and select from among the many preconfigured sounds in the Music Feature's sonic vocabulary. Sounds can be quickly auditioned before they are selected.

lected.
Lst Price: IBM Music Feature,
\$495. Requires: Full-length, 8-bit
expansion slot; external stereo
amplifier and speakers or stereo
headphones; software for
sequencing, composing, and
editing music; DOS 2.0 or later.
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CIRCLE 666 ON READER SERVICE CARD

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AFTER HOURS



Roland's Desktop Studio Brings the Sound of Music to Your PC

BY JONATHAN MATZKIN The same PC technology that

boosts productivity can also unleash the creativity of would-be composers and bandleaders. But many an experienced PC jockey has little or no conception of how to make music with

The \$995 PC Desktop Music Studio, from RolandCorp US (a manufacturer of electronic musical instruments), includes everything you need to begin composing, playing, and recording electronic music of almost unlimited variety on your personal computer.

The system consists of a synthesizer module, a MIDI interface that ties the synthesizer to your CPU, and sequencing software. MIDI cables are also in-

cluded. The MT-32 synthesizer module looks different from tra-

AFTER HOURS INDEX

A Symphony of Sounds Make your PC sing with IBM's Music Feature and

Music Quest's MIDI Starter System Bach and the Beatles on CD-ROM CD-Ploy and CD-AudioFile

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ditional keyboard synthesizers, for an obvious reason: it lacks a keyboard. Its small, 1%- by 12hy 81/5-inch (HWD) case holds the tone-generating electronics that you'd find in a conventional synthesizer, but the MT-32 is controlled by software instead of a keyboard

The MPU-IPC MIDI interface links the MT-32 and the PC and can interface with other MIDI-compatible electronic devices, like Casio's MIDI guitar or a digital sampler.

The MPU-IPC-a 11/4- by 61/2- by 2-inch (HWD) external box-attaches to the PC via a cable and a half-length, 8-bit bus card. The interface connects to the MT-32 via MIDI cables and is compatible with Roland's industry-standard MPU-401 MIDI interface.

The Ease software drives the Desktop Music Studio. It works like a multitrack tape recorder but uses computer memory instead of tape. Rather than sound, the sequencer stores information-known as a sequence-that tells the MT-32 what notes to play and how to play them. Notes are entered from the PC keyboard with a mouse or with an optional MIDI controller.

Ease provides access to all of the MT-32's hardware features. You can select and modify sounds, increase or decrease the volume of a given sound, or adjust a variety of other musical

Like Roland's popular D-50 keyboard synthesizer, the MT-32 uses a process called LA (linear arithmetic) synthesis to eenerate sound.



The MPU-IPC MIDI interface connects the MI-32 to sour PC and can also face with a variety of MIDI-compatible electronic devices

The MT-32 is multitimbral, which means that it can simultaneously play two or more notes that do not have the same sound. Up to eight different timbres can be played at once, so you can assien the sound of an eight-note chord to up to eight different instruments. That total doesn't include the MT-32's realistic per-

cussion sounds Ease lacks some of the features found in professional-level sequencers, and the whole package is oriented for hobbyists and serious amateurs. The MT-32 synthesizer module is a very powerful instrument, however and can be used with more-sophisticated software if desired

List Price: PC Desktop Music Studio, \$995 Requires: 512K RAM: two disk draws: CGA, EGA. or Hercules graphics adapter; DOS 2.0 or later. RolandCorp US, 7200 Dominion Circle, Los Angeles, CA 90040; (213) 685-5141

CIRCLE 669 ON READER SERVICE CARD

H sourdon't have a MIDI kenboard to device, you OR OTHER BOL - Roland's Ease software matter of PC kreboard or moure. The tone and approf at fers

Work like this doesn't just happen.

LKXS RADIOGRAPHY OPERATING GROUP Review of Operations

During 1987, the LKXS radiography companies persond forward vigoreously with a series of grotant introduction and marketing programs designed to transform LKXS into a "new business" girded for continued growth in both the increasingly competitive U.S. biotechnelogy field and the unerging biotechnology market worldwide.

Profits Up in Growth Year

Throughout 1967, engployees worked dilipsely to insprove current product quality, control operating costs, and provide crustanding transcense service. As a result, LXXS recorded its post profit year ever desples substantial expendicures to develop and introduce the Model NGZ.



To foster continued growth in overseas starkets, we opened subsidiaries in Japan and Hong Kong. These consultments have strendy paid off with international sales accounting for 7% of total revenues. Next year, we expect a streng showing as these subsidiaries continue to enablish themselves.



To make sare we stay closely in touch with our customers, in 1987 the LKXS companies expanded their customer service areas by 20%, spending \$25 million to train their account management personnel.

Model NR² is a Success

The introduction of the Model NR² is a good example of our success in prensing technology forward and communicating the benefits of this new technology to benefitals and research institutes around the world

LKXS representatives introduced the Medel NR² at major conferences in the field, both in the United States and overseas, to an

Review of Operations



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